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(54) EMISSIVE DISPLAY ELEMENT

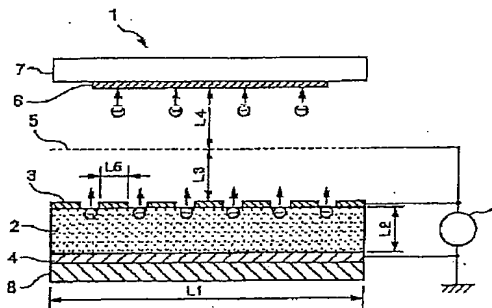
(57) Abstract:

PROBLEM TO BE SOLVED: To provide an emissive display element with which the constitution of a lightweight and small-sized plane display having a large display area is possible, discharge current is hardly affected by a working environment, large current is stably obtainable and uniform characteristics and improved durability are obtainable.

SOLUTION: This emissive display element has an antiferroelectric substance 2, a front surface electrode 3 and rear surface electrode 4 for impressing AC electric fields on the antiferroelectric substance 2 and a phosphor layer 6 for emitting light by the cold electrons radiated when the alternate electric fields are impressed on the antiferroelectric substance 2. The front surface electrode 3 and rear surface electrode 4 are respectively disposed above and below the antiferroelectric substance 2 and at least one of both electrodes may be a comb-shaped or holed electrode. Glass 7 is disposed in the upper part of the antiferroelectric substance 2. The phosphor layer 6 and the front surface electrode 3 are disposed between the glass 7 and the antiferroelectric substance 2. At least either of vacuum gas, insulator or (n) type semiconductor may be disposed between the

antiferroelectric substance 2 and the phosphor layer 6. The cold electron release side of the antiferroelectric substance 2 may be approximately flat.

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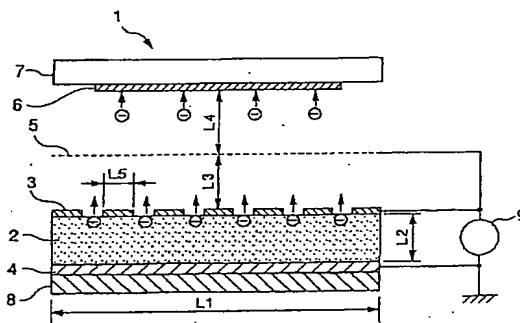
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(54) 【発明の名称】 発光表示素子

(57) 【要約】

【課題】 大きな表示面積の平面表示器を軽量、小型に構成でき、放出電流が動作環境の影響を受け難く安定的に大きな電流を得ることができると共に、特性の均一化や耐久性の向上を図れる発光表示素子を提供する。

【解決手段】 反強誘電体2と、反強誘電体2に交番電界を印加するための上面電極3及び裏面電極4と、反強誘電体2に交番電界を印加したときに放射される冷電子によって発光する蛍光体層6とを備えている。上面電極3及び裏面電極4は反強誘電体2の上下にそれぞれ配設され、この両電極の内少なくとも一方は楕円又は孔開き電極であっても良い。反強誘電体2の上部にガラス7を配設し、ガラス7及び反強誘電体2の間に蛍光体層6及び上面電極3とを配設する。反強誘電体2と蛍光体層6との間に、少なくとも真空ガス、絶縁体又はn型半導体のいずれか一つが設けられていても良い。反強誘電体2の冷電子放出側は、略平坦であっても良い。



【特許請求の範囲】

【請求項1】 反強誘電体(2)と、
反強誘電体(2)に交番電界を印加するための上面電極(3)及び裏面電極(4)と、
反強誘電体(2)に交番電界を印加したときに放射される冷電子によって発光する蛍光体層(6)とを備えたことを特徴とする発光表示素子。

【請求項2】 前記上面電極(3)及び裏面電極(4)は前記反強誘電体(2)の上下にそれぞれ配設され、この両電極の内少なくとも一方は櫛形又は孔開き電極であることを特徴とする請求項1に記載の発光表示素子。

【請求項3】 前記反強誘電体(2)の上部に配設されたガラス(7)と、
ガラス(7)及び反強誘電体(2)の間に配設された蛍光体層(6)及び上面電極(3)とを備えたことを特徴とする請求項1又は2に記載の発光表示素子。

【請求項4】 前記反強誘電体(2)と蛍光体層(6)との間に、少なくとも真空ガス、絶縁体又はn型半導体のいずれか一つが設けられていることを特徴とする請求項1、2又は3に記載の発光表示素子。

【請求項5】 前記反強誘電体(2)の冷電子放出側は、略平坦であることを特徴とする請求項1、2、3又は4に記載の発光表示素子。

【請求項6】 前記発光表示素子を1個以上並べて平面表示器を構成したことを特徴とする請求項1、2、3、4又は5に記載の発光表示素子。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、反強誘電体の冷電子放出を利用して蛍光体を発光させる発光表示素子に関する。

【0002】

【従来の技術】コンピュータとのマンマシンインターフェース用の表示器として、小型で使いやすい液晶表示器、プラズマ表示器等の平面表示器が良く使用されるようになって来ている。この平面表示器の一つとして、低消費電力駆動に適し、またカラー表示化にも対応が容易である電界放出表示素子を用いたものが研究されるようになってきている。

【0003】このような電界放出表示素子に関して、例えば特開平7-64490号の公報に記載されているものがあり、図12にその電界放出表示素子のセルの代表的な構造を示している。以下、図12に基づいて説明する。セル81内の下部に絶縁体基板82が設けられ、絶縁体基板82の上部表面には、下部電極層83、強誘電体層84及び上部電極層85が順に積層して形成されている。セル81内の上部にはガラスセル86が設けられ、上部電極層85の対向するガラスセル86の内側には蛍光体層87が形成されている。また、下部電極層83には電源88が接続され、上部電極層85はアース

(接地)に接続されている。さらに、好ましくは蛍光体層87とガラスセル86との間にはバイアス電極89が形成され、バイアス電極89には正のバイアス電源90が接続されている。そして、セル81内は真空状態に保持されている。

【0004】このようなセル81において、下部電極層83に電源88によって所定電圧以上の交番パルス電圧を印加すると、強誘電体層84内で強誘電体の残留分極が反転させられ、この反転によって強電界が生じる。強誘電体層84に対して所定値以上の強電界を印加すると、トンネル効果によって強誘電体中の電子が上部電極層85によって引き出され、外界に放出される。(これが、いわゆる電界電子放出現象と呼ばれる。)この上部電極層85から放出された電子が蛍光体層87に照射されることにより、蛍光体が発光するようになっている。このとき、バイアス電極89に所定値以上の正のバイアス電圧を印加すると、上部電極層85から放出された電子が加速されて蛍光体層87に照射されるので、蛍光体の発光を増大させることができる。

【0005】このような構成にしたので、比較的低電圧で発光させることができると共に、積層体の薄膜化及びセルの小型化ができるので、表示素子の精細化ができ、また平面で薄型の表示素子を製造することができる。また、蛍光体層の種類を変えることによって、容易にカラー表示化にも対応できる。

【0006】また、特開平7-57620号の公報においては、p-n接合の半導体を用いた電界放出表示素子の提案がなされている。図13に、このような電界放出表示素子のチップ部の構造を示している。p型半導体基板91の上部に、ピラミッド状に形成されたチップ部95を設けられ、さらにこのチップ部95を含んだp型半導体基板91の上部表面にはp型不純物領域92が形成されている。p型不純物領域92の上部には、n型不純物領域93が形成されている。そして、前記チップ部95の表面部分にはn型不純物93で浅い接合領域98が形成され、チップ部95自体がp-n接合を有している。

【0007】p型半導体基板91の上部には、チップ部95の周辺にp型半導体基板91の表面を酸化させ、かつ、チップ部95を露出させる開口部を有する酸化膜94が形成され、この酸化膜94の上部には、酸化膜94の開口部に対応するピンホールを有する絶縁膜96が形成されている。絶縁膜96の上部には、絶縁膜96のピンホールに対応する開口部を有する導電層97が形成されている。

【0008】このような構成において、p型半導体基板91の下部に設けられた電極(図示せず)に対して導電層97に所定電圧値の逆バイアス電圧を印加すると、チップ部95のp-n接合部からトンネル効果による電子が放出される。この電界放出電子をチップ部95に対向

して導電層97の上部に配設された蛍光体層(図示せず)に照射させることにより、発光させることができる。このとき、チップ部95及び蛍光体層を含む表示素子部は真空中に保持されている。

【0009】

【発明が解決しようとする課題】しかしながら、上記のような電界放出電子を利用した発光表示素子においては、次のような問題点を有している。強誘電体を使用する場合には、放出電流を蛍光体層87に能率良く到達させるために、電子放出部及び蛍光体層が配設されたセル81内を所定の真空度を満たす真空状態に保持しなければならない。よって、ガラスにより密封するための強度が必要となる等の構造上の制約がある。このことは、表示面積の大きな平面表示器を製造するに当たっては、軽量、小型化の面で不利となっている。

【0010】また、交番電圧を印加する必要があるが、図14のように強誘電体層84の上下方向に交番電界Eが印加されると、圧電効果によってこの電界に垂直な方向には機械的な縮みが発生し、平行な方向には機械的な伸びが発生する。強誘電体層84の上下の接合部は上部電極層85及び下部電極層83によって拘束されているので、この歪みによる強誘電体層84内部の応力によってストレスが溜まる。よって、強誘電体層84の耐久性を低下させ、表示素子の寿命を劣化させている。

【0011】また、図15に示すように、強誘電体は印加電界Eが零に戻っても残留分極Psが残る。しかるに、上部電極層85の直ぐ上部に蛍光体層87を配設して平面表示器とした場合には、蛍光体も誘電体であるので、強誘電体層84の上記残留分極Psに影響を受けて蛍光体層87にも残留分極が生じる。これによって、蛍光体の不整発光が起きたり、応答速度が遅くなる等の問題が生じる。このことは、真空を使用しない平面表示器を構成するのに不利な点となる。

【0012】一方、p-n接合を使用する場合には、放出電流が小さいので、電子放出部及び蛍光体層が配設される真空中の真空度及び真空中に含まれる微量物質の性質(以後、真空の質と呼ぶ)に放出電流が大きく影響を受け易い。このために、表示素子部を所定の真空度及び真空の質を満たす真空中に保持する必要がある。

【0013】また、電界電子を放出し易くするために、放出部を鋭利な状態にする必要がある。このために、放出部をピラミッド状のチップにしたり、又は四角柱状のチップにしたりしているが、このような鋭利なチップは微小寸法(上記従来の例では、2 μ mの大きさのピラミッド状チップ)で形成しなければならない。ところが、このように微小寸法で形成するには、例えばマイクロマシーニング等のエッチングによらなければならないので、形成の工程が非常に煩雑になる。この結果、表示面積の大型化に際して、電子放出部の特性の均一性を得ることが困難となる。

【0014】また、ピラミッド状のチップ部95の先端の鋭利な部分が真空中に存在するプラスイオンにエッチングされて丸く成り易く、このため長時間の放出では放出電流が小さくなってしまふ。さらに、先端の鋭利な部分の電流容量が小さいので、放出電流を大きくするには限界がある。

【0015】本発明は、上記従来の問題点に着目してなされたものであり、大きな表示面積の平面表示器を軽量、小型に構成することが容易であり、放出電流が動作環境の影響を受け難く安定的に大きな電流を得ることができると共に、特性の均一化や耐久性の向上を図れる発光表示素子を提供することを目的としている。

【0016】

【課題を解決するための手段】本発明の発光表示素子は、反強誘電体2と、反強誘電体2に交番電界を印加するための上面電極3及び裏面電極4と、反強誘電体2に交番電界を印加したときに放射される冷電子によって発光する蛍光体層6とを備えている。

【0017】反強誘電体を使用するので、等しい大きさの交番電界を印加しても強誘電体に比べて分極が大きくなり、このとき放出される冷電子の量も多い。よって、放出電流が大きくなる。また、この放出電流は真空度等による影響を受け難いので、真空を使用しなくても安定した大きさの放出電流が得られる。また、交番電界による圧電効果によって反強誘電体に発生する歪みは、電界方向及びこれに直角な方向に対して共に伸びるので、反強誘電体の内部応力は小さくなり、よって寿命が向上される。また、印加電界を零にしたとき分極が零になるので、反強誘電体と蛍光体を直接接触させて平面表示器を構成したときでも、蛍光体の不整発光は生じず、蛍光体の発光の応答性が良くなる。

【0018】p-n接合の半導体を使用した場合より大きな放射電流を真空度等に影響を受けずに得られるので、発光の安定性が良くなる。そして、冷電子は反強誘電体の平坦な表面からでも容易に放射されるので、電子放出部をピラミッド状や四角柱のように鋭利な形状に形成する必要がなくなる。よって、表示素子の形成工程が簡単化されるので特性の均一な素子が容易に得られ、大面積の表示器が制作し易くなる。また、平面部から電子を放出するので、大電流を流すことも可能となり、さらに長時間電流を流しても放出部の形状が変化することが無く、表示の安定性が良くなる。

【0019】また、上記発光表示素子において、前記上面電極3及び裏面電極4は前記反強誘電体2の上下にそれぞれ配設され、この両電極の内少なくとも一方は櫛形又は孔開き電極であっても良い。

【0020】上記構成としたので、平面表示器を構成するときに、各単位表示セルを平面状にマトリックス的に配列し、反強誘電体の上下にお互いに直交して設けた上面電極3及び裏面電極4をマトリックス的に選択して交

番電界を印加することによって、この単位表示セルの任意の位置を発光させることが容易となる。この結果、平面表示器を構成することが容易となる。

【0021】また、上記発光表示素子は、前記反強誘電体2の上部に配設されたガラス7と、ガラス7及び反強誘電体2の間に配設された蛍光体層6及び上面電極3とを備えても良い。

【0022】上記構成としたので、反強誘電体から放出される冷電子は蛍光体層に到達して蛍光体を発光させる。この発光を、蛍光体層の上部のガラスを通してセル外部から確認される。よって、簡単な構造で発光表示素子を構成できる。

【0023】また、上記発光表示素子は、前記反強誘電体2と蛍光体層6との間に、少なくとも真空ガス、絶縁体又はn型半導体のいずれか一つが設けられていても良い。

【0024】真空ガスを使用した場合、反強誘電体から放出された冷電子が非常に効率良く蛍光体層に到達するので、蛍光体の発光度を大きくできる。真空ガスの代わりに絶縁体又はn型半導体を使用する場合は、真空度を保つための強度を要するような構造にしなくても良いので構造が簡単になる。さらに、表示素子全体を半導体によって構成できるので、構成が簡単になり、薄型、軽量及び小型化を図れる。

【0025】また、上記発光表示素子は、前記反強誘電体2の冷電子放出側は略平坦であった方が好ましい。

【0026】これによって、電流を大きくできるので発光を明るくし易い。また、表示特性が長期間使用しても安定する。

【0027】また、前記発光表示素子を1個以上並べて平面表示器を構成しても良い。

【0028】上記構成としたので、構造の簡単で、かつ、均一な表示特性が安定的に得られる大面積の平面表示器が容易に構成される。

【0029】

【発明の実施の形態及び実施例】以下に、図を参照しながら発明の実施の形態及び実施例を説明する。図1は、第一実施例を表した発光表示素子の断面図である。発光表示素子1は、反強誘電体2をベースにして構成されている。絶縁基板8上に、順に裏面電極4、反強誘電体2及び櫛形の上面電極3を形成している。上面電極3の上方には所定の距離を置いてガラス7を配設しており、反強誘電体2に対向し、かつ、ガラス7の下面には蛍光体層6を形成している。また、本実施例では上面電極3とガラス7との間の空間を真空状態に保持しており、この空間にグリッド電極5を設けている。そして、裏面電極4をアース（接地）に接続し、上面電極3と裏面電極4との間に正の交番電圧を印加する交番電源9を接続している。また、グリッド電極5には正のバイアス電圧を印加する電源を接続するが、本実施例では交番電源9を兼

用してグリッド電極5に接続している。

【0030】次に、図2乃至図4に基づいて作用について説明する。図2は反強誘電体2の分極特性の一例を表しており、図3は交番電源9の出力波形の例を、また図4は反強誘電体2の電子放出特性の例をそれぞれ表している。上記のような表示素子において、交番電源9によって上面電極3と裏面電極4に交番電界を印加すると、反強誘電体2には0から E_{max} の間で周期的な電界が印加される。 E_{max} の手前には、図2のように印加電界によって分極Pが急激に誘起されるスイッチングフィールドSがある。印加電界が0からスイッチングフィールドSまで印加される間に、電子が反強誘電体2の上面電極3の近傍上面に誘引される。

【0031】このとき、スイッチングフィールドSにおいて分極が急激に誘起されると、誘引された上記電子がこの分極に反発し、トンネル効果によって櫛形の上面電極3の隙間の部分に位置する反強誘電体2の表面から電子（以後、冷電子と呼ぶ）が放出されるようになる。図4は、この冷電子が急激に発生するときの様子を示しており、スイッチングフィールドSの近傍の印加電界では冷電子が急激に放出される。放出された冷電子はグリッド電極5によって加速され、グリッド電極5を通過した後に蛍光体層6に到達し、蛍光体層6は所定の色で発光する。この発光は、ガラス7を通して外部から認識される。

【0032】スイッチングフィールドSを過ぎたら上記冷電子の放出は停止し、印加電界が0に戻って再びスイッチングフィールドSの近傍になるまで冷電子の放出は停止したままである。印加電界を所定の周波数で繰り返すと、以上の冷電子の放出及び放出停止を繰り返し、これにより蛍光体層6は発光及び発光停止の過程を繰り返す。上記印加電界の周波数を所定の周波数以上にする

と、蛍光体層6の残留発光もあるので、人間の目には発光が継続している如く認識される。したがって、電界の印加及び否印加を外部のコントローラ（図示せず）等によって制御することによって、表示器として利用が可能となる。

【0033】反強誘電体2としては、例えばPb-La-Zr-Sn-Ti-O系やPb-Nb-Zr-Sn-Ti-O系、Pb-La-Zr-Ti-O系のセラミックス等を使用することができる。本実施例では、PLZSTセラミックスと呼ばれる、「 $Pb_{0.97}La_{0.02}Zr_{0.66}Sn_{0.24}Ti_{0.1}O_3$ 」を採用し、このセラミックス層の厚みL2は $30\mu m$ としている。前記図2の分極特性は、この採用したPLZSTセラミックスの特性を示している。

【0034】交番電源9の印加電界の波形は、このPLZSTセラミックスの分極特性に適合させている。例えば、図3のようにピーク電界値が $4.5KV/cm$ で、 $100Hz$ の三角波の正の交番電界を印加した。ここで、印加

するピーク電界値は反強誘電体2の前記スイッチングフィールドSによって設定される。尚、交番電界の波形は三角波に限定するものでなく、例えば矩形のパルス波形でも良く、交番周波数は反強誘電体2の応答性等に対応して数KHzにしても良い。

【0035】上面電極3及び裏面電極4は、例えばPt、Au、Ag-Pd、Pd、Al、Cu等で構成される。上面電極3と裏面電極4との間に交番電界を印加したとき、反強誘電体2の表面から電子が放出され易いように、上面電極3は隙間を有する構造にした方が好ましい。よって、本実施例では図1のような櫛形の上面電極3を採用しているが、上記の理由によってこの上面電極3は、平面電極の内側に所定の大きさの孔状の隙間を設けたような電極としても良い。

【0036】そして、例えばドット表示で文字や図形を表示するような平面表示器においては、表示セルを平面状に縦横に行列させて並べ、マトリックス的に各表示セルをアクセスして駆動する場合が多い。このときは、行列を指定する櫛形の電極を反強誘電体2の上下に互いに直交させて設け、これを上面電極3及び裏面電極4とした方が好ましい。本実施例では、上面電極3のみを櫛形にしており、この櫛形の電極幅L5を0.3mmとしている。

【0037】また、絶縁基板8は例えばAl₂O₃、MgO、Si等で構成されるが、ガラスであっても良い。蛍光体層6が発光したときに外部からその発光が見れるように、蛍光体層6はガラス7の下面に形成しているが、ガラス7を上記のような絶縁基板8と同様の絶縁体で構成しても、本発明の反強誘電体による発光の作用は変わらない。

【0038】また、本実施例では、図1のような1辺L1が10mmの四角形状の絶縁基板8上に上記の表示素子1を形成し、上面電極3とグリッド電極5間の距離L3を10mm、グリッド電極5と蛍光体層6間の距離L4を5mmとしている。このように、上面電極3と蛍光体層6間の距離が長いので、放出電子が蛍光体層6に到達し易いように、上面電極3とガラス7との間の空間を真空状態に保持しており、この空間にグリッド電極5を設けている。上記真空の真空度は10Paより低くした程度で良く、従来よりも真空度に影響を受け難くなっている。これは、前記冷電子が櫛形の上面電極3の隙間の部分に位置する反強誘電体2の表面全体から放出されるので、放出電流が大きくなり、真空度に影響を受け難くなったためである。

【0039】次に、第二実施例を図5を参照して説明する。図5は、表示素子1の単位表示セルの断面を表している。本実施例では、第一実施例における真空の代わりに、次のような中間物質10を使用している。例えば、シリコンオキシサイトのような絶縁体を数百Å以下の厚さにして使用したり、n型半導体又は不活性ガス等を使用

する。その他の構成は、第一実施例と同様である。

【0040】この場合も、前述と同様にして上面電極3と裏面電極4の間に交番電界を印加すると、反強誘電体2の上部表面から冷電子が放出される。上記中間物質10が極めて薄い絶縁体のときは、この冷電子は、グリッド電極5によって加速されて数百Å以下の厚さの絶縁体を通過し、蛍光体層6に到達する。また、n型半導体のときは、上記冷電子が注入されると、この冷電子は内部の浮遊電子と共にグリッド電極5によって加速され、蛍光体層6に到達する。不活性ガスのときは、上記冷電子は不活性ガス中を同様に加速され、蛍光体層6に到達する。

【0041】このように、真空を使用しないので、表示器の表示面に使用するガラス7が真空によって潰れないように強度を保つための構造が複雑になる等の問題が無い。よって、表示器を大型化し易くなる。また、真空を使用する場合に比べて、非常に薄型の表示器を構成することができる。

【0042】第三実施例を、図6に基づいて説明する。図6は、表示素子1の単位表示セルの断面を表している。絶縁基板8上に、上述の実施例と同様に順に裏面電極4、反強誘電体2及び櫛形の上面電極3を形成している。上面電極3の上方には所定の距離を置いてガラス7を配設しており、ガラス7の下面にはグリッド電極5を形成している。さらに、グリッド電極5の下面には、反強誘電体2に対向して蛍光体層6を形成している。また、本実施例では上面電極3とガラス7との間に、第二実施例と同様の中間物質10を使用している。各電極への交番電源9の接続は、これまでの実施例と同様である。

【0043】この実施例の作用は、上記第二実施例と同様になる。そして、この場合にも真空を使用しないで、表示器を大型化し易くなる。さらに、グリッド電極5をガラス7と蛍光体層6の間に形成したので、蛍光体層6と上面電極3との距離を第二実施例よりも小さくでき、よって、さらに薄型の表示器を構成することができる。

【0044】第四実施例を、図7に示される表示素子1の単位表示セルの断面図に基づいて説明する。本実施例では、絶縁基板8の上部に順に裏面電極4及び反強誘電体2を形成している。反強誘電体2の上面には、櫛形の上面電極3及び蛍光体層6を交互に形成している。すなわち、櫛形の電極と電極の間に蛍光体層6が配設された状態である。そして、上面電極3及び蛍光体層6の上面にガラス7が配設されている。

【0045】前述と同様にして上面電極3と裏面電極4の間に交番電界を印加すると、反強誘電体2の上部表面から冷電子が放出される。この冷電子は直ぐ上面にある蛍光体層6に照射され、外部からガラス7によって蛍光体の発光が確認される。このように、本実施例では、反

強誘電体 2 と蛍光体層 6 とを接触させて配設しているので前実施例のような中間物質 10 が無く、表示器を構成したとき非常に薄型にすることができる。また、真空を使用しないので表示器を大型化し易くなる。

【0046】第五実施例を、図 8 を参照して説明する。本実施例は、縦横に平面状に単位表示セルを配置して平面表示器を構成する例を示しており、図 8 はその表示素子 1 の断面図を表している。絶縁基板 8 の上部に順に裏面電極 4、反強誘電体 2 及び上面電極 3 を形成しているが、裏面電極 4 と上面電極 3 はお互いに直交している櫛形の電極としている。例えば、図 8 のように平面表示器の $x-y$ 平面の x 軸と平行に裏面電極 4 の各櫛形電極を配列し、また、 y 軸と平行に上面電極 3 の各櫛形電極を配列する。各単位表示セル C には少なくとも 1 本の裏面電極 4 の櫛型電極と、少なくとも一本の上面電極 3 の櫛型電極が配設されている。本実施例では、各単位表示セル C に 1 本の裏面電極 4 と 2 本の上面電極 3 を配設しており、2 本の上面電極 3 の間に蛍光体層 6 を形成している。上面電極 3 の内側に、図 9 のように所定の大きさの孔を設け、この孔の中に蛍光体層 6 を形成しても良い。上面電極 3 及び蛍光体層 6 の直ぐ上面にガラス 7 を設けている。また、隣接した各単位表示セル C の上面電極 3 の間には、中間物質 11 を設ける。この中間物質 11 は、絶縁体（気体、液体、固体を問わない）又は空気や真空等で構成されても良い。

【0047】各単位表示セル C の上面電極 3 と裏面電極 4 との間に交番電界を印加すると、反強誘電体 2 の上部表面から冷電子が放出され、この冷電子が直ぐ上面にある蛍光体層 6 に照射されて蛍光体が発光する。このとき、上記交番電界は上面電極 3 と裏面電極 4 との間でマトリックス的に制御され、所定の位置の単位表示セル C が発光するように交番電界が印加される。すなわち、例えば各単位表示セル C 毎の裏面電極 4 は y 軸電界制御器 15 にそれぞれ電源線 $y1$ 、 $y2$ 、 $y3$ 等によって接続され、また各単位表示セル C 毎の上面電極 3 は x 軸電界制御器 16 にそれぞれ電源線 $x1$ 、 $x2$ 、 $x3$ 等によって接続される。そして、この x 軸電界制御器 16 及び y 軸電界制御器 15 には交番電源 9 が接続される。

【0048】図 10 は、 x 軸電界制御器 16 及び y 軸電界制御器 15 の電界制御の実施例を表している。 y 軸電界制御器 15 は、所定周期でサイクリックに各電源線 $y1$ 、 $y2$ 、 $y3$ 等を所定時間だけ交番電源 9 に接続する。電源線 $y1$ が交番電源 9 に接続されているとき、 x 軸電界制御器 16 は、電源線 $y1$ に対応した裏面電極 4 上に位置する各単位表示セル C11、C21、C31 等の中で、点灯すべきセルに対応する上面電極 3 の電源線 $x1$ 、 $x2$ 、 $x3$ 等を交番電源 9 に接続する。これによって、点灯すべきセルにのみ交番電界が印加され、このセルが上記所定時間のみ点灯する。このようにして、交番電源 9 に順次接続された各電源線に対応して、点灯すべ

きセルに対応する電源線 $x1$ 、 $x2$ 、 $x3$ 等を交番電源 9 に接続して行き、マトリックス的に所定の位置の単位表示セル C を発光させることができる。

【0049】本実施例では、裏面電極 4 と上面電極 3 とを共に櫛形の電極にして、かつ、お互いに直交するように配設しているので、各単位表示セルをマトリックス的に選択して任意に表示できる。よって、文字や図形等を表示できる平面表示器として構成することが可能となる。前実施例同様に反強誘電体 2 と蛍光体層 6 とを接触させて配設しているので、表示器が非常に薄型になる。また、真空を使用しないときは表示器を大型化し易くなる。上面電極 3 の内側に孔を設けてこの孔の中に蛍光体層 6 を形成すると、各単位表示セル同士の発光の干渉が少なくなる。

【0050】次に、第六実施例を図 11 に基づいて説明する。図 11 は、第 5 実施例と同様に平面表示器を構成するときの表示素子 1 の断面図を表している。絶縁基板 8 の上部に順に裏面電極 4、反強誘電体 2 及び上面電極 3 を形成し、裏面電極 4 と上面電極 3 は前述同様にお互いに直交している櫛形の電極としている。また、上面電極 3 の上面に蛍光体層 6 を形成し、蛍光体層 6 の上面にガラス 7 を配設している。反強誘電体 2 とガラス 7 との間は、前実施例と同様に中間物質 11 の絶縁体又は空気や真空等で構成しても良い。

【0051】各単位表示セル C の上面電極 3 と裏面電極 4 の間に交番電界を印加すると、反強誘電体 2 の上部表面から冷電子が放出され、この冷電子が中間物質 11 を通過して蛍光体層 6 に照射されて蛍光体が発光する。このとき、上記交番電界は前実施例同様にして、上面電極 3 と裏面電極 4 との間でマトリックス的に制御され、所定の位置の単位表示セル C が発光するように交番電界が印加される。よって、任意の表示セルをマトリックス的に選択して表示でき、文字や図形等の平面表示器として構成することが可能となる。

【0052】尚、これまで説明した発光表示素子の実施例において、反強誘電体に交番電界を印加して冷電子を放出させる作用を数値を参照して説明したが、本発明の作用及び効果はこれらの数値のみに限定されるものではなく、使用する反強誘電体の特性に応じて、あるいは制作する表示器の仕様、性能等によって上記数値は設定される。したがって、上記数値以外の設定によって、又は他の特性の反強誘電体を使用して、同様の作用及び効果を有するものを、本発明の主旨の範囲内において構成できることは言うまでもない。

【0053】

【発明の効果】反強誘電体を使用したので、放出電流を大きくできる。また、真空を使用しなくても安定した大きさの放出電流が得られる。また、交番電界の印加による圧電効果によって発生する反強誘電体の内部応力は小さいので、表示素子の寿命を向上できる。さらに、上記

印加電界を零にしたとき分極が零になるので、平面表示器を構成したときでも蛍光体の不整発光は無く、また蛍光体の発光の応答性を向上できる。この結果、耐久性があり、表示特性が優れた明るい発光表示素子の制作が可能となる。

【0054】冷電子の放出部を精密な形成工程によって形成する必要がなくなったので、表示素子の形成工程が簡単化された。よって、特性の均一な素子が容易に得られ、大面積の表示器が制作し易くなった。また、平面部から電子を放出するので、大電流を流すことも可能となり、さらに長時間電流を流しても安定した表示が得られるようになった。よって、表示性能及び信頼性を向上できた。

【0055】平面表示器を構成するときに、各単位表示セルを平面状にマトリックス的に配列し、反強誘電体の上下にお互いに直交している上面電極3及び裏面電極4を少なくとも両電極のいずれか一方を楕形にして設け、この両電極をマトリックス的に選択して交番電界を印加することができる。よって、平面表示器の任意の単位表示セルを発光させることが容易となった。このとき、上面電極3の内側に孔を設けてこの孔に蛍光体層を形成すると、各単位表示セル同士の発光の干渉を少なくできる。この結果、平面表示器を容易に構成することが可能となった。

【0056】反強誘電体から放出される冷電子は蛍光体層に到達して蛍光体を発光させ、この発光を蛍光体層の上部のガラスを通してセル外部から確認できる。よって、簡単な構造で発光表示素子を構成できた。

【0057】真空ガスを使用した場合は、反強誘電体から放出された冷電子が非常に効率良く蛍光体層に到達するので、蛍光体の発光度を大きくできる。真空ガスの代わりに絶縁体又はn型半導体を使用した場合は、構造を簡単にできる。このとき、表示素子全体を半導体によって構成できるので、構成が簡単になり、薄型、軽量及び小型化に容易に対応可能となった。

【0058】放出電流を大きくできるので、発光を明るくできる。また、表示特性が長期間使用しても安定しているの、信頼性を向上できた。

【0059】構造が簡単で、かつ、均一な表示特性が安定的に得られる大面積の平面表示器が容易に構成できるようになった。

【図面の簡単な説明】

【図1】本発明の第一実施例に係わる表示素子の断面図である。

【図2】第一実施例の作用を説明する反強誘電体の電界一分極特性図である。

【図3】第一実施例の作用を説明する交番電界の波形図である。

【図4】第一実施例の作用を説明する反強誘電体の放出電荷特性図である。

【図5】本発明の第二実施例に係わる表示素子断面図である。

【図6】本発明の第三実施例に係わる表示素子断面図である。

【図7】本発明の第四実施例に係わる表示素子断面図である。

【図8】本発明の第五実施例に係わる表示素子断面図である。

【図9】本発明の第五実施例に係わる孔開き上面電極の例である。

【図10】本発明の第五実施例の作用を説明する電界制御の例である。

【図11】本発明の第六実施例に係わる表示素子断面図である。

【図12】従来技術の強誘電体使用の表示素子の断面図である。

【図13】従来技術のp-n接合使用の表示素子の断面図である。

【図14】従来技術の強誘電体使用の表示素子の内部ストレスの説明図である。

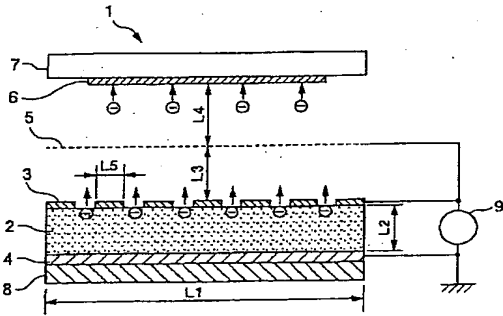
【図15】従来技術の強誘電体の電界一分極特性図である。

【符号の説明】

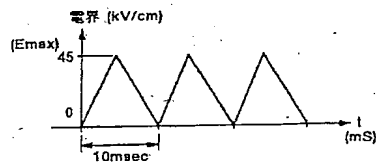
- 1 発光表示素子
- 2 反強誘電体
- 3 上面電極
- 4 裏面電極
- 5 グリッド電極
- 6 蛍光体層
- 7 ガラス
- 8 絶縁基板
- 9 交番電極
- 10 中間物質
- 11 中間物質
- 15 y軸電界制御器
- 16 x軸電界制御器
- 81 セル
- 82 絶縁基板
- 83 下部電極層
- 84 強誘電体層
- 85 上部電極層
- 86 ガラスセル
- 87 蛍光体層
- 88 電源
- 89 バイアス電極
- 90 バイアス電源
- 91 p型半導体基板
- 92 p型不純物領域
- 93 n型不純物領域
- 94 酸化膜

- 95 チップ部
96 絶縁膜
97 導電層
98 接合領域

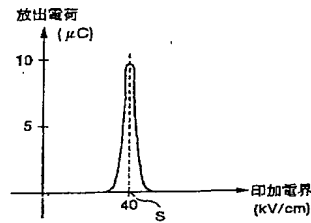
【図1】



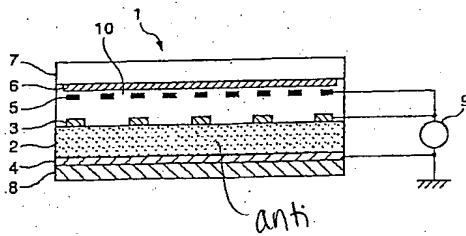
【図3】



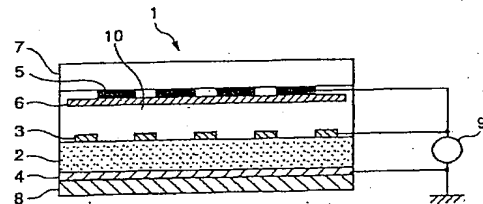
【図4】



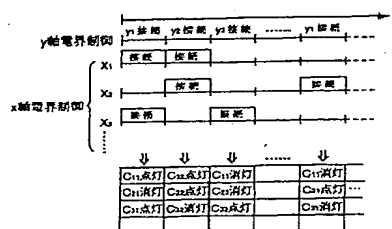
【図5】



【図6】

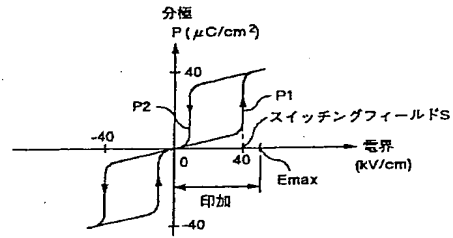


【図10】

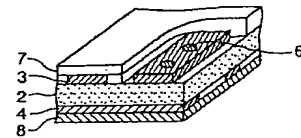


- E_{max} 印加最大電界値
P 分極
S スイッチングフィールド

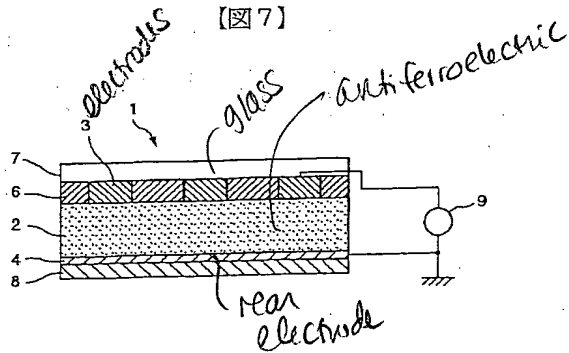
【図2】



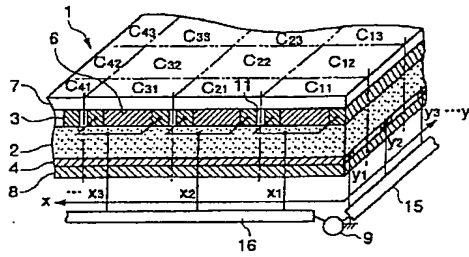
【図9】



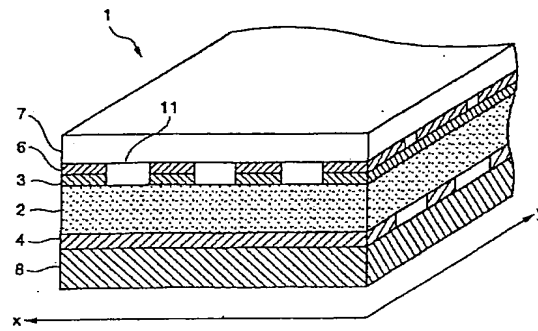
【図7】



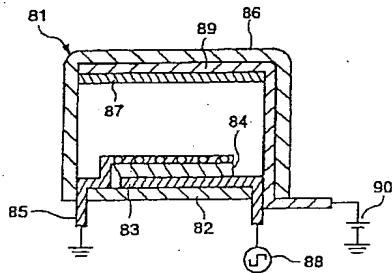
【図8】



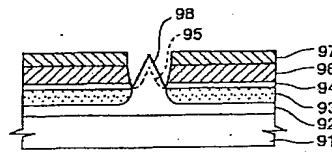
【図11】



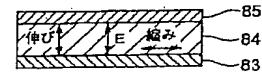
【図12】



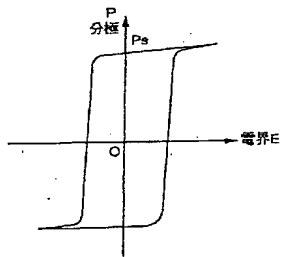
【図13】



【図14】



【図15】



JAPANESE

[JP,09-090882,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION
TECHNICAL PROBLEM MEANS EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

* NOTICES *

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2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] Antiferroelectric crystal (2) Antiferroelectric crystal (2) Top-face electrode for impressing an alternating electric field (3) And rear-face electrode (4) Antiferroelectric crystal (2) Fluorescent substance layer which emits light with the cold electron emitted when an alternating electric field is impressed (6) Luminescence display device characterized by having.

[Claim 2] Said top-face electrode (3) And rear-face electrode (4) Said antiferroelectric crystal (2) It is the luminescence display device according to claim 1 which is arranged up and down, respectively and is characterized by at least one side being Kushigata or a porous dehiscence feeding pole among these two electrodes.

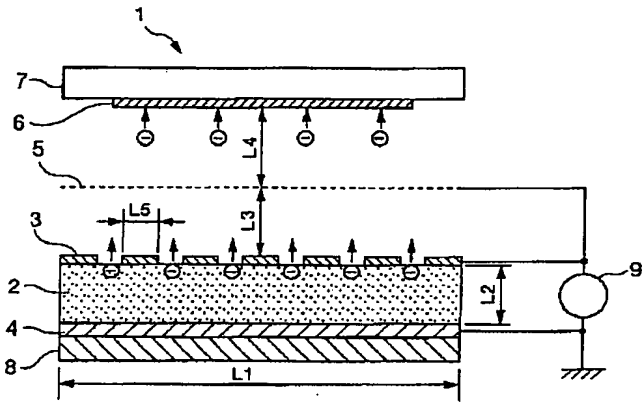
[Claim 3] Said antiferroelectric crystal (2) Glass arranged in the upper part (7) Glass (7) And antiferroelectric crystal (2) Fluorescent substance layer arranged in between (6) And top-face electrode (3) Luminescence display device according to claim 1 or 2 characterized by having.

[Claim 4] Said antiferroelectric crystal (2) Fluorescent substance layer (6) Luminescence display device according to claim 1, 2, or 3 characterized by preparing any one of vacuum gas, an insulator, or the n-type semiconductors at least in between.

[Claim 5] Said antiferroelectric crystal (2) A cold electron emission side is a luminescence display device according to claim 1, 2, 3, or 4 characterized by being abbreviation flatness.

[Claim 6] The luminescence display device according to claim 1, 2, 3, 4, or 5 characterized by having put said one or more luminescence display devices in order, and constituting a flat-surface drop.

[Translation done.]



[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the luminescence display device which makes a fluorescent substance emit light using the cold electron emission of an antiferroelectric crystal.

[0002]

[Description of the Prior Art] As a drop for man machine interfaces with a computer, it is small and flat-surface drops which are easy to use, such as a liquid crystal display and a plasma display, are coming to be used well. That to which it was suitable for the low-power drive, and correspondence used the easy field emission display device also for color display-ization as one of the flat-surface drop of this is studied.

[0003] There are some which are indicated by the official report of JP,7-64490,A concerning such a field emission display device, and the typical structure of the cel of the field emission display device is shown in drawing 12. Hereafter, it explains based on drawing 12. The insulator substrate 82 is formed in the lower part in a cel 81, and the lower electrode layer 83, the ferroelectric layer 84, and the up electrode layer 85 carry out a laminating to order, and are formed in the up front face of the insulator substrate 82. A glass cell 86 is formed in the upper part in a cel 81, and the fluorescent substance layer 87 is formed inside the glass cell 86 which the up electrode layer 85 counters. Moreover, a power source 88 is connected to the lower electrode layer 83, and the up electrode layer 85 is connected to the ground (touch-down). Furthermore, between the fluorescent substance layer 87 and a glass cell 86, the bias electrode 89 is formed preferably, and the forward bias power supply 90 is connected to the bias electrode 89. And the inside of a cel 81 is held at the vacua.

[0004] In such a cel 81, if the alternation pulse voltage more than a predetermined electrical potential difference is impressed to the lower electrode layer 83 according to a power source 88, the remanence of a ferroelectric will be reversed within the ferroelectric layer 84, and strong electric field will arise by this reversal. If the strong electric field beyond a predetermined value are impressed to the ferroelectric layer 84, the electron in a ferroelectric will be pulled out by the up electrode layer 85, and will be emitted to the external world by the tunnel effect. (This is called the so-called field-electron-emission phenomenon.) When the electron emitted from this up electrode layer 85 is irradiated by the fluorescent substance layer 87, a fluorescent substance emits light. [0005] which can increase luminescence of a fluorescent substance since the electron emitted from the up electrode layer 85 will be accelerated and the fluorescent substance layer 87 will irradiate, if the forward bias voltage beyond a predetermined value is impressed to the bias electrode 89 at this time Since thin-film-izing of a layered product and the miniaturization of a cel can be performed while being able to make light emit by the low battery comparatively, since it was made such a configuration, minute-ization of a display device can be performed and a thin display device can be manufactured at a flat surface. Moreover, it can respond also to color display-ization easily by changing the class of fluorescent substance layer.

[0006] Moreover, in the official report of JP,7-57620,A, the proposal of the field emission display device using the semi-conductor of p-n junction is made. The structure of the chip section of such a field emission display device is shown in drawing 13. The chip section 95 formed in the upper part of the p type semiconductor substrate 91 in the shape of a pyramid can be formed, and p mold impurity range 92 is formed in the up front face of the p type semiconductor substrate 91 which contained this chip section 95 further. n mold impurity range 93 is formed in the upper part of p mold impurity range 92. And the shallow junction field 98 is formed in the surface part of said chip section 95 with n mold impurity 93, and chip section 95 the very thing has p-n junction.

[0007] The oxide film 94 which has opening to which the front face of the p type semiconductor substrate 91 is oxidized around the chip section 95, and the chip section 95 is exposed is formed in the upper part of the p type semiconductor substrate 91, and the insulator layer 96 which has a pinhole corresponding to opening of an oxide film 94 is formed in the upper part of this oxide film 94. The conductive layer 97 which has opening corresponding to the pinhole of an insulator layer 96 is formed in the upper part of an insulator layer 96.

[0008] In such a configuration, if the reverse bias electrical potential difference of a predetermined electrical-

potential-difference value is impressed to a conductive layer 97 to the electrode (not shown) prepared in the lower part of the p type semiconductor substrate 91, the electron by the tunnel effect will be emitted from the p-n junction section of the chip section 95. Light can be made to emit by making this field emission electron irradiate the fluorescent substance layer (not shown) which countered the chip section 95 and was arranged in the upper part of a conductive layer 97. At this time, the display device section containing the chip section 95 and a fluorescent substance layer is held in the vacuum.

[0009]

[Problem(s) to be Solved by the Invention] However, in the luminescence display device using the above field emission electrons, it has the following troubles. When using a ferroelectric, in order to make the emission current reach in the fluorescent substance layer 87 well, the inside of the cel 81 in which the electron emission section and a fluorescent substance layer were arranged must be held to the vacua which fills a predetermined degree of vacuum. Therefore, there is constraint on structures, like the reinforcement for sealing with glass is needed. In manufacturing the big flat-surface drop of a screen product, this is disadvantageous at Men of a light weight and a miniaturization. [0010] Moreover, although it is necessary to impress an alternation electrical potential difference, if an alternating electric field E is impressed in the vertical direction of the ferroelectric layer 84 like drawing 14, according to the piezo-electric effect, mechanical shrinkage will occur in the direction perpendicular to this electric field, and mechanical elongation will occur in the parallel direction. Since the joint of the upper and lower sides of the ferroelectric layer 84 is restrained by the up electrode layer 85 and the lower electrode layer 83, stress collects with the stress of the ferroelectric layer 84 interior by this distortion. Therefore, the endurance of the ferroelectric layer 84 is reduced and the life of a display device is degraded.

[0011] Moreover, it is Remanence Ps even if, as for a ferroelectric, the impression electric field E return to zero, as shown in drawing 15. It remains. However, since a fluorescent substance is also a dielectric when [of the up electrode layer 85] the fluorescent substance layer 87 is immediately arranged in the upper part and it considers as a flat-surface drop, it is the above-mentioned remanence Ps of the ferroelectric layer 84. In response to effect, a remanence arises also in the fluorescent substance layer 87. By this, irregular luminescence of a fluorescent substance occurs or problems, like a speed of response becomes slow arise. This serves as a disadvantageous point for constituting the flat-surface drop which does not use a vacuum.

[0012] On the other hand, since the emission current is small when using p-n junction, the emission current tends to receive effect in the property (it is henceforth called the vacuous quality) of the minute amount matter contained in the degree of vacuum in the vacuum in which the electron emission section and a fluorescent substance layer are arranged, and a vacuum greatly. For this reason, it is necessary to hold the display device section in the vacuum with which a predetermined degree of vacuum and the vacuous quality are filled.

[0013] Moreover, in order to make an electric-field electron easy to emit, it is necessary to change the emission section into a sharp condition. For this reason, although the emission section is made a pyramid-like chip or is made the square pole-like chip, such a sharp chip must be formed with a minute dimension (the above-mentioned conventional example pyramid-like chip with a magnitude of 2 micrometers). However, since it must be based on etching of my chroma C NINGU etc. in order to form with a minute dimension in this way for example, the process of formation becomes very complicated. Consequently, on the occasion of enlargement of a screen product, it becomes difficult to acquire the homogeneity of the property of the electron emission section.

[0014] Moreover, it will be etched into the plus ion with which a part with the sharp tip of the pyramid-like chip section 95 exists in a vacuum, and will be easy to change round, and, for this reason, the emission current will become small by emission of long duration. Furthermore, since the current capacity of a part with a sharp tip is small, there is a limitation in enlarging the emission current.

[0015] This invention is made paying attention to the above-mentioned conventional trouble, and it aims at offering the luminescence display device which can aim at equalization of a property, and improvement in endurance while it can acquire a stably big current that it is easy to constitute the flat-surface drop of a big screen product lightweight and small, and the emission current cannot receive environmental influence of operation easily.

[0016]

[Means for Solving the Problem] The luminescence display device of this invention is equipped with the antiferroelectric crystal 2, the top-face electrode 3 for impressing an alternating electric field to an antiferroelectric crystal 2 and the rear-face electrode 4, and the fluorescent substance layer 6 that emits light with the cold electron emitted when an alternating electric field is impressed to an antiferroelectric crystal 2.

[0017] Since an antiferroelectric crystal is used, there are also many amounts of the cold electron emitted at this time by polarization becoming large compared with a ferroelectric even if it impresses the alternating electric field of equal magnitude. Therefore, the emission current becomes large. Moreover, since this emission current cannot be easily influenced by a degree of vacuum etc., the emission current of the magnitude stabilized even if it did not use a vacuum is acquired. Moreover, since distortion generated in an antiferroelectric crystal is extended [as opposed to / both / the direction of electric field, and a direction right-angled to this] according to the piezo-electric effect by

the alternating electric field, the internal stress of an antiferroelectric crystal becomes small and, therefore, its life improves. Moreover, since polarization becomes zero when impression electric field are made into zero, even when an antiferroelectric crystal and a fluorescent substance are contacted directly and a flat-surface drop is constituted, irregular luminescence of a fluorescent substance is not produced but the responsibility of luminescence of a fluorescent substance becomes good.

[0018] Since a bigger radiation current than the case where the semi-conductor of p-n junction is used is acquired without receiving effect in a degree of vacuum etc., the stability of luminescence becomes good. Since a cold electron is easily emitted even from the flat front face of an antiferroelectric crystal, it becomes unnecessary and to form the electron emission section in a sharp configuration like the shape of a pyramid, or the square pole.

Therefore, since the formation process of a display device is simplified, a component with a uniform property is obtained easily, and it becomes easy to make the drop of a large area. Moreover, since an electron is emitted from the flat-surface section, it also becomes possible to pass a high current, even if it passes a long duration current further, the configuration of the emission section does not change and the stability of a display becomes good.

[0019] Moreover, in the above-mentioned luminescence display device, said antiferroelectric crystal 2 may be arranged up and down, respectively, and at least one side of said top-face electrode 3 and the rear-face electrode 4 may be Kushigata or a porous dehiscence feeding pole among these two electrodes.

[0020] Since it considered as the above-mentioned configuration, when a flat-surface drop is constituted, it becomes easy to make the location of the arbitration of this unit display cel emit light by arranging each unit display cel in matrix to a plane, choosing in matrix the top-face electrode 3 and the rear-face electrode 4 of an antiferroelectric crystal which it intersected perpendicularly and were prepared for each other up and down, and impressing an alternating electric field. Consequently, it becomes easy to constitute a flat-surface drop.

[0021] Moreover, the above-mentioned luminescence display device may be equipped with the glass 7 arranged in the upper part of said antiferroelectric crystal 2, and the fluorescent substance layer 6 and the top-face electrode 3 which were arranged between glass 7 and an antiferroelectric crystal 2.

[0022] Since it considered as the above-mentioned configuration, the cold electron emitted from an antiferroelectric crystal reaches a fluorescent substance layer, and makes a fluorescent substance emit light. This luminescence is checked from the cel outside through the glass of the upper part of a fluorescent substance layer. Therefore, a luminescence display device can consist of easy structures.

[0023] Moreover, as for the above-mentioned luminescence display device, any one of vacuum gas, an insulator, or the n-type semiconductors may be prepared at least between said antiferroelectric crystals 2 and fluorescent substance layers 6.

[0024] Since the cold electron emitted from the antiferroelectric crystal reaches a fluorescent substance layer very efficiently when vacuum gas is used, whenever [luminescence / of a fluorescent substance] can be enlarged. When using an insulator or a n-type semiconductor instead of vacuum gas, since it is not necessary to make it the structure where the reinforcement for maintaining a degree of vacuum is required, structure becomes easy. Furthermore, since a semi-conductor can constitute the whole display device, a configuration becomes easy and a thin shape, a light weight, and a miniaturization can be attained.

[0025] Moreover, it is more desirable for the above-mentioned luminescence display device to be abbreviation flatness for the cold electron emission side of said antiferroelectric crystal 2.

[0026] Since a current can be enlarged, it is easy to make luminescence bright by this. Moreover, [0027] stabilized even if a display property uses it for a long period of time Moreover, said one or more luminescence display devices may be put in order, and a flat-surface drop may be constituted.

[0028] Since it considered as the above-mentioned configuration, the flat-surface drop of a large area with which a uniform display property is acquired stably simply [structure] is constituted easily.

[0029]

[The gestalt and example] of implementation of invention Below, the gestalt and example of implementation of invention are explained, referring to drawing. Drawing 1 is the sectional view showing the first example of a luminescence display device. The luminescence display device 1 uses an antiferroelectric crystal 2 as the base, and is constituted. On an insulating substrate 8, the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 of Kushigata are formed in order. A predetermined distance is kept above the top-face electrode 3, glass 7 is arranged, and an antiferroelectric crystal 2 is countered, and the fluorescent substance layer 6 is formed in the inferior surface of tongue of glass 7. Moreover, in this example, the space between the top-face electrode 3 and glass 7 is held to the vacua, and the grid electrode 5 is formed in this space. And the rear-face electrode 4 was connected to the ground (touch-down), and the alternation power source 9 which impresses a forward alternation electrical potential difference between the top-face electrode 3 and the rear-face electrode 4 is connected. Moreover, although the power source which impresses forward bias voltage is connected to the grid electrode 5, in this example, the alternation power source 9 was made to serve a double purpose, and it has connected with the grid electrode 5.

[0030] Next, an operation is explained based on drawing 2 thru/or drawing 4. Drawing 2 expresses an example of the polarization property of an antiferroelectric crystal 2, and drawing 4 expresses the example of the electron emission characteristic of an antiferroelectric crystal 2 for the example of the output wave [drawing 3] of the alternation power source 9 again, respectively. If an alternating electric field is impressed to rear-face inter-electrode 4 as the top-face electrode 3 according to the alternation power source 9 in the above display devices, in an antiferroelectric crystal 2, it is 0 to E_{max} . Periodic electric field are impressed in between. E_{max} There is the switching field S where induction of the polarization P is rapidly carried out by impression electric field like drawing 2 to the front. While impression electric field are impressed from 0 to the switching field S, an electron is induced the near top face of the top-face electrode 3 of an antiferroelectric crystal 2.

[0031] If induction of the polarization is rapidly carried out in the switching field S at this time, the attracted above-mentioned electron will oppose this polarization, and an electron (it is henceforth called a cold electron) will come to be emitted from the front face of the antiferroelectric crystal 2 located in the part of the clearance between the top-face electrodes 3 of Kushigata according to the tunnel effect. Drawing 4 shows the situation in case this cold electron is generated rapidly, and a cold electron is rapidly emitted in the impression electric field near the switching field S. It is accelerated with the grid electrode 5, the emitted cold electron reaches the fluorescent substance layer 6, after passing the grid electrode 5, and the fluorescent substance layer 6 emits light by the predetermined color. This luminescence is recognized from the outside through glass 7.

[0032] Emission of a cold electron has stopped until emission of the above-mentioned cold electron stopped, impression electric field returned to 0 and it became near the switching field S again, when passing the switching field S. If impression electric field are repeated on a predetermined frequency, the above emission and emission halt of a cold electron will be repeated, and, thereby, the fluorescent substance layer 6 will repeat the process of luminescence and a luminescence halt. Since there is also residual luminescence of the fluorescent substance layer 6 when the frequency of the above-mentioned impression electric field is carried out more than a predetermined frequency, it is recognized as luminescence is continuing to human being's eyes. Therefore, use becomes possible as a drop by controlling impression and un-impressing by an external controller (not shown) etc. [of electric field]

[0033] As an antiferroelectric crystal 2, the ceramics of a Pb-La-Zr-Sn-Ti-O system, a Pb-Nb-Zr-Sn-Ti-O system, and a Pb-La-Zr-Ti-O system etc. can be used, for example. In this example, "Pb_{0.97} La_{0.02} Zr_{0.66} Sn_{0.24} Ti_{0.103}" called the PLZST ceramics is adopted, and thickness L2 of this ceramic layer is set to 30 micrometers. The polarization property of said drawing 2 shows the property of this adopted PLZST ceramics.

[0034] The wave of the impression electric field of the alternation power source 9 is fitted to the polarization property of this PLZST ceramics. For example, peak electric-field values are 45 kV/cm like drawing 3. The forward alternating electric field of a 100Hz triangular wave was impressed. Here, the peak electric-field value to impress is set up by said switching field S of an antiferroelectric crystal 2. In addition, the wave of an alternating electric field may not be limited to a triangular wave, and a rectangular pulse shape may be used, for example, an alternation frequency corresponds to the responsibility of an antiferroelectric crystal 2 etc., and it is several kHz. You may carry out.

[0035] the top-face electrode 3 and the rear-face electrode 4 -- for example, Pt, Au, Ag-Pd, Pd, aluminum, and Cu etc. -- it is constituted. It is more desirable to make the top-face electrode 3 into the structure of having a clearance so that an electron may be easy to be emitted from the front face of an antiferroelectric crystal 2 when an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4. Therefore, although the top-face electrode 3 of Kushigata like drawing 1 is adopted in this example, it is good also as an electrode with which this top-face electrode 3 prepared the clearance between the shape of a hole of predetermined magnitude inside the flat electrode for the above-mentioned reason.

[0036] And in a flat-surface drop which displays an alphabetic character and a graphic form, for example by dot display, a plane is made to line up in all directions, a display cel is put in order, and in matrix, each display cel is accessed and is driven in many cases. At this time, it is [antiferroelectric crystal / 2] more desirable to have made each intersect perpendicularly up and down, to have prepared, and to make this into the top-face electrode 3 and the rear-face electrode 4 in the electrode of Kushigata which specifies a matrix. Only the top-face electrode 3 is made into Kushigata in this example, and it is the electrode width of face L5 of this Kushigata. It may be 0.3mm.

[0037] moreover, the insulating substrate 8 -- for example, aluminum 2O₃, Mg O, and Si etc. -- you may be glass although constituted. When the fluorescent substance layer 6 emits light, the fluorescent substance layer 6 is formed in the inferior surface of tongue of glass 7 so that the luminescence can be seen from the exterior, but even if it constitutes glass 7 from the same insulator as the above insulating substrates 8, an operation of luminescence by the antiferroelectric crystal of this invention does not change.

[0038] Moreover, 1 side L1 like [in this example] drawing 1 The above-mentioned display device 1 is formed on the insulating substrate 8 of the shape of a square which is 10mm, and it is the distance L3 between the top-face electrode 3 and the grid electrode 5. Distance L4 between 10mm, the grid electrode 5, and the fluorescent substance layer 6 It may be 5mm. Thus, since the distance between the top-face electrode 3 and the fluorescent substance

layer 6 is long, the space between the top-face electrode 3 and glass 7 is held to the vacuum, and the grid electrode 5 is provided in this space so that the emission electron may tend to reach the fluorescent substance layer 6. The degree of vacuum of the above-mentioned vacuum is 10Pa. It is good at extent made low, and has been hard coming to receive effect in a degree of vacuum conventionally. Since said cold electron is emitted from the whole front face of the antiferroelectric crystal 2 located in the part of the clearance between the top-face electrodes 3 of Kushigata, this is because the emission current becomes large and it was hard coming to receive effect in a degree of vacuum. [0039] Next, the second example is explained with reference to drawing 5. Drawing 5 expresses the cross section of the unit display cel of a display device 1. In this example, the following intermediate products 10 are used instead of the vacuum in the first example. For example, an insulator like silicon OKISAITO is used, making it into the thickness of hundreds of Å or less, or a n-type semiconductor or inert gas is used. Other configurations are the same as that of the first example.

[0040] If an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4 like the above-mentioned also in this case, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2. At the time of an insulator when the above-mentioned intermediate product 10 is very thin, this cold electron is accelerated with the grid electrode 5, and an insulator with a thickness of hundreds of Å or less is passed, and it reaches the fluorescent substance layer 6. Moreover, if the above-mentioned cold electron is poured in at the time of a n-type semiconductor, it will be accelerated with the grid electrode 5 with an internal suspension electron, and this cold electron will reach the fluorescent substance layer 6. At the time of inert gas, the above-mentioned cold electron is similarly accelerated in the inside of inert gas, and the fluorescent substance layer 6 is reached.

[0041] Thus, since a vacuum is not used, there are no problems, like the structure for maintaining reinforcement so that the glass 7 used for the screen of a drop may not be crushed by the vacuum becomes complicated. Therefore, it becomes easy to enlarge a drop. Moreover, a very thin drop can be constituted compared with the case where a vacuum is used.

[0042] The third example is explained based on drawing 6. Drawing 6 expresses the cross section of the unit display cel of a display device 1. On an insulating substrate 8, the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 of Kushigata are formed in order like an above-mentioned example. A predetermined distance is kept above the top-face electrode 3, glass 7 is arranged, and the grid electrode 5 is formed in the inferior surface of tongue of glass 7. Furthermore, an antiferroelectric crystal 2 is countered and the fluorescent substance layer 6 is formed in the inferior surface of tongue of the grid electrode 5. Moreover, in this example, the same intermediate product 10 as the 2nd example is used between the top-face electrode 3 and glass 7. The connection of the alternation power source 9 with each electrode is the same as that of an old example.

[0043] An operation of this example becomes being the same as that of the second example of the above. And since a vacuum is not used also in this case, it becomes easy to enlarge a drop. Furthermore, since the grid electrode 5 was formed between glass 7 and the fluorescent substance layer 6, distance of the fluorescent substance layer 6 and the top-face electrode 3 can be made smaller than the second example, and a therefore further thin drop can be constituted.

[0044] The fourth example is explained based on the sectional view of the unit display cel of the display device 1 shown in drawing 7. In this example, the rear-face electrode 4 and the antiferroelectric crystal 2 are formed in the upper part of an insulating substrate 8 in order. The top-face electrode 3 and the fluorescent substance layer 6 of Kushigata are formed in the top face of an antiferroelectric crystal 2 by turns. Namely, it is in the condition that the fluorescent substance layer 6 was arranged between the electrodes of Kushigata. And glass 7 is arranged in the top face of the top-face electrode 3 and the fluorescent substance layer 6.

[0045] If an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4 like the above-mentioned, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2. This cold electron is irradiated by the fluorescent substance layer 6 which is in a top face immediately, and luminescence of a fluorescent substance is checked with glass 7 from the exterior. Thus, in this example, since an antiferroelectric crystal 2 and the fluorescent substance layer 6 are contacted and are arranged, when there is no intermediate product 10 like a last example and a drop is constituted, it can be made a thin shape very much. Moreover, since a vacuum is not used, it becomes easy to enlarge a drop.

[0046] The fifth example is explained with reference to drawing 8. The example which this example arranges a unit display cel to a plane in all directions, and constitutes a flat-surface drop is shown, and drawing 8 expresses the sectional view of the display device 1. Although the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 are formed in the upper part of an insulating substrate 8 in order, the rear-face electrode 4 and the top-face electrode 3 are used as the electrode of Kushigata which lies at right angles to each other. For example, each Kushigata electrode of the rear-face electrode 4 is arranged like drawing 8 to the x axis of the x-y flat surface of a flat-surface drop, and parallel, and each Kushigata electrode of the top-face electrode 3 is arranged to the y-axis and parallel. The tandem-type electrode of the tandem-type electrode of at least one rear-face electrode 4 and at least one top-face electrode 3 is arranged by each unit display cel C. In this example, one rear-face electrode 4 and

two top-face electrodes 3 are arranged in each unit display cel C, and the fluorescent substance layer 6 is formed between two top-face electrodes 3. Inside the top-face electrode 3, the hole of predetermined magnitude may be prepared like drawing 9, and the fluorescent substance layer 6 may be formed into this hole. the top-face electrode 3 and the fluorescent substance layer 6 -- glass 7 is immediately formed in the top face. Moreover, an intermediate product 11 is formed between the top-face electrodes 3 of each unit display cel C which adjoined. This intermediate product 11 may consist of an insulator (a gas, a liquid, and a solid-state are not asked) or air, a vacuum, etc.

[0047] If an alternating electric field is impressed between the top-face electrode 3 of each unit display cel C, and the rear-face electrode 4, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2, the fluorescent substance layer 6 which has this cold electron in a top face immediately will irradiate, and a fluorescent substance will emit light. At this time, the above-mentioned alternating electric field is controlled in matrix between the top-face electrode 3 and the rear-face electrode 4, and an alternating electric field is impressed so that the unit display cel C of a position may emit light. namely, the rear-face electrode 4 for every unit display cel C -- the y-axis electric-field controller 15 -- respectively -- the power-source line y1, y2, and y3 etc. -- it connects -- having -- moreover, the top-face electrode 3 for every unit display cel C -- the x-axis electric-field controller 16 -- respectively -- the power-source line x1, x2, and x3 etc. -- it connects. And the alternation power source 9 is connected to this x-axis electric-field controller 16 and the y-axis electric-field controller 15.

[0048] Drawing 10 expresses the example of electric-field control of the x-axis electric-field controller 16 and the y-axis electric-field controller 15. the y-axis electric-field controller 15 -- a predetermined period -- cyclic -- each power-source line y1, y2, and y3 etc. -- only predetermined time is connected to the alternation power source 9. power-source line y1 the time of connecting with the alternation power source 9 -- the x-axis electric-field controller 16 -- power-source line x1 The power-source line x1 of the top-face electrode 3 corresponding to the cel which should be turned on in each unit display cels C11 and C21 and C31 grade which are located on the corresponding rear-face electrode 4, x2, and x3 etc. -- it connects with the alternation power source 9. An alternating electric field is impressed only to the cel which should be turned on by this, and this cel turns on only the above-mentioned predetermined time by it. the power-source line x1 corresponding to the cel which should be turned on to the alternation power source 9 corresponding to each power-source line by which sequential connection was made, x2, and x3 etc. -- it can connect with the alternation power source 9, and can go, and the unit display cel C of a position can be made to emit light in matrix [thus,]

[0049] In both this examples, since it is arranging so that the rear-face electrode 4 and the top-face electrode 3 may be used as the electrode of Kushigata and it may intersect perpendicularly with each other, each unit display cel is chosen in matrix, and it can display on arbitration. Therefore, it becomes possible to constitute as a flat-surface drop which can display an alphabetic character, a graphic form, etc. Since an antiferroelectric crystal 2 and the fluorescent substance layer 6 are contacted and are arranged like a last example, a drop becomes a thin shape very much. Moreover, when not using a vacuum, it becomes easy to enlarge a drop. If a hole is prepared inside the top-face electrode 3 and the fluorescent substance layer 6 is formed into this hole, interference of luminescence of each unit display cels will decrease.

[0050] Next, the sixth example is explained based on drawing 11. Drawing 11 expresses the sectional view of the display device 1 when constituting a flat-surface drop like the 5th example. The rear-face electrode 4, an antiferroelectric crystal 2, and the top-face electrode 3 are formed in the upper part of an insulating substrate 8 in order, and the rear-face electrode 4 and the top-face electrode 3 are used as the electrode of Kushigata which lies at right angles to each other like the above-mentioned. Moreover, the fluorescent substance layer 6 is formed in the top face of the top-face electrode 3, and glass 7 is arranged in the top face of the fluorescent substance layer 6. You may constitute from the insulator or air of an intermediate product 11, a vacuum, etc. like a last example between an antiferroelectric crystal 2 and glass 7.

[0051] If an alternating electric field is impressed between the top-face electrode 3 of each unit display cel C, and the rear-face electrode 4, a cold electron is emitted from the up front face of an antiferroelectric crystal 2, this cold electron will pass an intermediate product 11, will be irradiated by the fluorescent substance layer 6, and a fluorescent substance will emit light. At this time, the above-mentioned alternating electric field is controlled in matrix between the top-face electrode 3 and the rear-face electrode 4 like a last example, and an alternating electric field is impressed so that the unit display cel C of a position may emit light. Therefore, the display cel of arbitration is chosen in matrix, and can be displayed, and it becomes possible to constitute as flat-surface drops, such as an alphabetic character and a graphic form.

[0052] In addition, in the example of the luminescence display device explained until now, although the operation which an alternating electric field is impressed to an antiferroelectric crystal, and makes a cold electron emit was explained with reference to the numeric value, an operation and effectiveness of this invention are not limited only to these numeric values, and the above-mentioned numeric value is set up with the specification of the drop to make, the engine performance, etc., corresponding to the property of the antiferroelectric crystal to be used.

therefore, a setup of those other than the above-mentioned numeric value -- or it cannot be overemphasized that the

antiferroelectric crystal of other properties is used and what has the same operation and effectiveness can be constituted within the limits of the main point of this invention.

[0053]

[Effect of the Invention] Since the antiferroelectric crystal was used, the emission current can be enlarged. Moreover, the emission current of the magnitude stabilized even if it did not use a vacuum is acquired. Moreover, since the internal stress of the antiferroelectric crystal generated according to the piezo-electric effect by impression of an alternating electric field is small, the life of a display device can be improved. Furthermore, since polarization becomes zero when the above-mentioned impression electric field are made into zero, even when a flat-surface drop is constituted, there is no irregular luminescence of a fluorescent substance, and it can improve the responsibility of luminescence of a fluorescent substance. Consequently, it is durable and work of the bright luminescence display device excellent in the display property is attained.

[0054] Since it became unnecessary to have formed the emission section of a cold electron with the precise formation process, the formation process of a display device was simplified. Therefore, a component with a uniform property is obtained easily and it becomes easy to make the drop of a large area. Moreover, since the electron was emitted from the flat-surface section, it also becomes possible to pass a high current and the display stabilized even if it passed the long duration current further came to be obtained. Therefore, the display engine performance and dependability have been improved.

[0055] When a flat-surface drop is constituted, each unit display cel can be arranged in matrix to a plane, at least, either of the two electrodes can be made into Kushigata, the top-face electrode 3 and the rear-face electrode 4 of an antiferroelectric crystal which lie at right angles to each other up and down can be prepared, these two electrodes can be chosen in matrix, and an alternating electric field can be impressed. Therefore, it became easy to make the unit display cel of the arbitration of a flat-surface drop emit light. If a hole is prepared inside the top-face electrode 3 and a fluorescent substance layer is formed in this hole at this time, interference of luminescence of each unit display cels can be lessened. Consequently, it became possible to constitute a flat-surface drop easily.

[0056] The cold electron emitted from an antiferroelectric crystal reaches a fluorescent substance layer, makes a fluorescent substance emit light, and can check this luminescence from the cel outside through the glass of the upper part of a fluorescent substance layer. Therefore, the luminescence display device has consisted of easy structures.

[0057] Since the cold electron emitted from the antiferroelectric crystal reaches a fluorescent substance layer very efficiently when vacuum gas is used, whenever [luminescence / of a fluorescent substance] can be enlarged. Structure can be simplified when an insulator or a n-type semiconductor is used instead of vacuum gas. Since the semi-conductor constituted the whole display device at this time, the configuration became easy and correspondence of it was attained easily at the thin shape, the light weight, and the miniaturization.

[0058] Since the emission current can be enlarged, luminescence can be made bright. Moreover, since it was stable even if the display property used it for a long period of time, dependability has been improved.

[0059] The flat-surface drop of a large area with which a display property with simply uniform structure is acquired stably can constitute now easily.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the luminescence display device which makes a fluorescent substance emit light using the cold electron emission of an antiferroelectric crystal.

[0002]

[Description of the Prior Art] As a drop for man machine interfaces with a computer, it is small and flat-surface drops which are easy to use, such as a liquid crystal display and a plasma display, are coming to be used well. That to which it was suitable for the low-power drive, and correspondence used the easy field emission display device also for color display-ization as one of the flat-surface drop of this is studied.

[0003] There are some which are indicated by the official report of JP,7-64490,A concerning such a field emission display device, and the typical structure of the cel of the field emission display device is shown in drawing 12. Hereafter, it explains based on drawing 12. The insulator substrate 82 is formed in the lower part in a cel 81, and the lower electrode layer 83, the ferroelectric layer 84, and the up electrode layer 85 carry out a laminating to order, and are formed in the up front face of the insulator substrate 82. A glass cell 86 is formed in the upper part in a cel 81, and the fluorescent substance layer 87 is formed inside the glass cell 86 which the up electrode layer 85 counters. Moreover, a power source 88 is connected to the lower electrode layer 83, and the up electrode layer 85 is connected to the ground (touch-down). Furthermore, between the fluorescent substance layer 87 and a glass cell 86, the bias electrode 89 is formed preferably, and the forward bias power supply 90 is connected to the bias electrode 89. And the inside of a cel 81 is held at the vacua.

[0004] In such a cel 81, if the alternation pulse voltage more than a predetermined electrical potential difference is impressed to the lower electrode layer 83 according to a power source 88, the remanence of a ferroelectric will be reversed within the ferroelectric layer 84, and strong electric field will arise by this reversal. If the strong electric field beyond a predetermined value are impressed to the ferroelectric layer 84, the electron in a ferroelectric will be pulled out by the up electrode layer 85, and will be emitted to the external world by the tunnel effect. (This is called the so-called field-electron-emission phenomenon.) When the electron emitted from this up electrode layer 85 is irradiated by the fluorescent substance layer 87, a fluorescent substance emits light. [0005] which can increase luminescence of a fluorescent substance since the electron emitted from the up electrode layer 85 will be accelerated and the fluorescent substance layer 87 will irradiate, if the forward bias voltage beyond a predetermined value is impressed to the bias electrode 89 at this time Since thin-film-izing of a layered product and the miniaturization of a cel can be performed while being able to make light emit by the low battery comparatively, since it was made such a configuration, minute-ization of a display device can be performed and a thin display device can be manufactured at a flat surface. Moreover, it can respond also to color display-ization easily by changing the class of fluorescent substance layer.

[0006] Moreover, in the official report of JP,7-57620,A, the proposal of the field emission display device using the semi-conductor of p-n junction is made. The structure of the chip section of such a field emission display device is shown in drawing 13. The chip section 95 formed in the upper part of the p type semiconductor substrate 91 in the shape of a pyramid can be formed, and p mold impurity range 92 is formed in the up front face of the p type semiconductor substrate 91 which contained this chip section 95 further. n mold impurity range 93 is formed in the upper part of p mold impurity range 92. And the shallow junction field 98 is formed in the surface part of said chip section 95 with n mold impurity 93, and chip section 95 the very thing has p-n junction.

[0007] The oxide film 94 which has opening to which the front face of the p type semiconductor substrate 91 is oxidized around the chip section 95, and the chip section 95 is exposed is formed in the upper part of the p type semiconductor substrate 91, and the insulator layer 96 which has a pinhole corresponding to opening of an oxide film 94 is formed in the upper part of this oxide film 94. The conductive layer 97 which has opening corresponding to the pinhole of an insulator layer 96 is formed in the upper part of an insulator layer 96.

[0008] In such a configuration, if the reverse bias electrical potential difference of a predetermined electrical-

potential-difference value is impressed to a conductive layer 97 to the electrode (not shown) prepared in the lower part of the p type semiconductor substrate 91, the electron by the tunnel effect will be emitted from the p-n junction section of the chip section 95. Light can be made to emit by making this field emission electron irradiate the fluorescent substance layer (not shown) which countered the chip section 95 and was arranged in the upper part of a conductive layer 97. At this time, the display device section containing the chip section 95 and a fluorescent substance layer is held in the vacuum.

[0009]

[Problem(s) to be Solved by the Invention] However, in the luminescence display device using the above field emission electrons, it has the following troubles. When using a ferroelectric, in order to make the emission current reach in the fluorescent substance layer 87 well, the inside of the cel 81 in which the electron emission section and a fluorescent substance layer were arranged must be held to the vacua which fills a predetermined degree of vacuum. Therefore, there is constraint on structures, like the reinforcement for sealing with glass is needed. In manufacturing the big flat-surface drop of a screen product, this is disadvantageous in respect of a light weight and a miniaturization.

[0010] Moreover, although it is necessary to impress an alternation electrical potential difference, if an alternating electric field E is impressed in the vertical direction of the ferroelectric layer 84 like drawing 14, according to the piezo-electric effect, mechanical shrinkage will occur in the direction perpendicular to this electric field, and mechanical elongation will occur in the parallel direction. Since the joint of the upper and lower sides of the ferroelectric layer 84 is restrained by the up electrode layer 85 and the lower electrode layer 83, stress collects with the stress of the ferroelectric layer 84 interior by this distortion. Therefore, the endurance of the ferroelectric layer 84 is reduced and the life of a display device is degraded.

[0011] Moreover, it is Remanence Ps even if, as for a ferroelectric, the impression electric field E return to zero, as shown in drawing 15. It remains. However, since a fluorescent substance is also a dielectric when [of the up electrode layer 85] the fluorescent substance layer 87 is immediately arranged in the upper part and it considers as a flat-surface drop, it is the above-mentioned remanence Ps of the ferroelectric layer 84. In response to effect, a remanence arises also in the fluorescent substance layer 87. By this, irregular luminescence of a fluorescent substance occurs or problems, like a speed of response becomes slow arise. This serves as a disadvantageous point for constituting the flat-surface drop which does not use a vacuum.

[0012] On the other hand, since the emission current is small when using p-n junction, the emission current tends to receive effect in the property (it is henceforth called the vacuous quality) of the minute amount matter contained in the degree of vacuum in the vacuum in which the electron emission section and a fluorescent substance layer are arranged, and a vacuum greatly. For this reason, it is necessary to hold the display device section in the vacuum with which a predetermined degree of vacuum and the vacuous quality are filled.

[0013] Moreover, in order to make an electric-field electron easy to emit, it is necessary to change the emission section into a sharp condition. For this reason, although the emission section is made a pyramid-like chip or is made the square pole-like chip, such a sharp chip must be formed with a minute dimension (the above-mentioned conventional example pyramid-like chip with a magnitude of 2 micrometers). However, since it must be based on etching of my chroma C NINGU etc. in order to form with a minute dimension in this way for example, the process of formation becomes very complicated. Consequently, on the occasion of enlargement of a screen product, it becomes difficult to acquire the homogeneity of the property of the electron emission section.

[0014] Moreover, it will be etched into the plus ion with which a part with the sharp tip of the pyramid-like chip section 95 exists in a vacuum, and will be easy to change round, and, for this reason, the emission current will become small by emission of long duration. Furthermore, since the current capacity of a part with a sharp tip is small, there is a limitation in enlarging the emission current.

[0015] This invention is made paying attention to the above-mentioned conventional trouble, and it aims at offering the luminescence display device which can aim at equalization of a property, and improvement in endurance while it can acquire a stably big current that it is easy to constitute the flat-surface drop of a big screen product lightweight and small, and the emission current cannot receive environmental influence of operation easily.

[0016]

[Means for Solving the Problem] The luminescence display device of this invention is equipped with the antiferroelectric crystal 2, the top-face electrode 3 for impressing an alternating electric field to an antiferroelectric crystal 2 and the rear-face electrode 4, and the fluorescent substance layer 6 that emits light with the cold electron emitted when an alternating electric field is impressed to an antiferroelectric crystal 2.

[0017] Since an antiferroelectric crystal is used, there are also many amounts of the cold electron emitted at this time by polarization becoming large compared with a ferroelectric even if it impresses the alternating electric field of equal magnitude. Therefore, the emission current becomes large. Moreover, since this emission current cannot be easily influenced by a degree of vacuum etc., the emission current of the magnitude stabilized even if it did not use a vacuum is acquired. Moreover, since distortion generated in an antiferroelectric crystal is extended [as opposed

to / both / the direction of electric field, and a direction right-angled to this] according to the piezo-electric effect by the alternating electric field, the internal stress of an antiferroelectric crystal becomes small and, therefore, its life improves. Moreover, since polarization becomes zero when impression electric field are made into zero, even when an antiferroelectric crystal and a fluorescent substance are contacted directly and a flat-surface drop is constituted, irregular luminescence of a fluorescent substance is not produced but the responsibility of luminescence of a fluorescent substance becomes good.

[0018] Since a bigger radiation current than the case where the semi-conductor of p-n junction is used is acquired without receiving effect in a degree of vacuum etc., the stability of luminescence becomes good. Since a cold electron is easily emitted even from the flat front face of an antiferroelectric crystal, it becomes unnecessary and to form the electron emission section in a sharp configuration like the shape of a pyramid, or the square pole.

Therefore, since the formation process of a display device is simplified, a component with a uniform property is obtained easily, and it becomes easy to make the drop of a large area. Moreover, since an electron is emitted from the flat-surface section, it also becomes possible to pass a high current, even if it passes a long duration current further, the configuration of the emission section does not change and the stability of a display becomes good.

[0019] Moreover, in the above-mentioned luminescence display device, said antiferroelectric crystal 2 may be arranged up and down, respectively, and at least one side of said top-face electrode 3 and the rear-face electrode 4 may be Kushigata or a porous dehiscence feeding pole among these two electrodes.

[0020] Since it considered as the above-mentioned configuration, when a flat-surface drop is constituted, it becomes easy to make the location of the arbitration of this unit display cel emit light by arranging each unit display cel in matrix to a plane, choosing in matrix the top-face electrode 3 and the rear-face electrode 4 of an antiferroelectric crystal which it intersected perpendicularly and were prepared for each other up and down, and impressing an alternating electric field. Consequently, it becomes easy to constitute a flat-surface drop.

[0021] Moreover, the above-mentioned luminescence display device may be equipped with the glass 7 arranged in the upper part of said antiferroelectric crystal 2, and the fluorescent substance layer 6 and the top-face electrode 3 which were arranged between glass 7 and an antiferroelectric crystal 2.

[0022] Since it considered as the above-mentioned configuration, the cold electron emitted from an antiferroelectric crystal reaches a fluorescent substance layer, and makes a fluorescent substance emit light. This luminescence is checked from the cel outside through the glass of the upper part of a fluorescent substance layer. Therefore, a luminescence display device can consist of easy structures.

[0023] Moreover, as for the above-mentioned luminescence display device, any one of vacuum gas, an insulator, or the n-type semiconductors may be prepared at least between said antiferroelectric crystals 2 and fluorescent substance layers 6.

[0024] Since the cold electron emitted from the antiferroelectric crystal reaches a fluorescent substance layer very efficiently when vacuum gas is used, whenever [luminescence / of a fluorescent substance] can be enlarged. When using an insulator or a n-type semiconductor instead of vacuum gas, since it is not necessary to make it the structure where the reinforcement for maintaining a degree of vacuum is required, structure becomes easy. Furthermore, since a semi-conductor can constitute the whole display device, a configuration becomes easy and a thin shape, a light weight, and a miniaturization can be attained.

[0025] Moreover, it is more desirable for the above-mentioned luminescence display device to be abbreviation flatness for the cold electron emission side of said antiferroelectric crystal 2.

[0026] Since a current can be enlarged, it is easy to make luminescence bright by this. Moreover, [0027] stabilized even if a display property uses it for a long period of time Moreover, said one or more luminescence display devices may be put in order, and a flat-surface drop may be constituted.

[0028] Since it considered as the above-mentioned configuration, the flat-surface drop of a large area with which a uniform display property is acquired stably simply [structure] is constituted easily.

[0029]

[The gestalt and example] of implementation of invention Below, the gestalt and example of implementation of invention are explained, referring to drawing. Drawing 1 is the sectional view showing the first example of a luminescence display device. The luminescence display device 1 uses an antiferroelectric crystal 2 as the base, and is constituted. On an insulating substrate 8, the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 of Kushigata are formed in order. A predetermined distance is kept above the top-face electrode 3, glass 7 is arranged, and an antiferroelectric crystal 2 is countered, and the fluorescent substance layer 6 is formed in the inferior surface of tongue of glass 7. Moreover, in this example, the space between the top-face electrode 3 and glass 7 is held to the vacua, and the grid electrode 5 is formed in this space. And the rear-face electrode 4 was connected to the ground (touch-down), and the alternation power source 9 which impresses a forward alternation electrical potential difference between the top-face electrode 3 and the rear-face electrode 4 is connected. Moreover, although the power source which impresses forward bias voltage is connected to the grid electrode 5, in this example, the alternation power source 9 was made to serve a double purpose, and it has connected with the grid

electrode 5.

[0030] Next, an operation is explained based on drawing 2 thru/or drawing 4. Drawing 2 expresses an example of the polarization property of an antiferroelectric crystal 2, and drawing 4 expresses the example of the electron emission characteristic of an antiferroelectric crystal 2 for the example of the output wave [drawing 3] of the alternation power source 9 again, respectively. If an alternating electric field is impressed to rear-face inter-electrode 4 as the top-face electrode 3 according to the alternation power source 9 in the above display devices; in an antiferroelectric crystal 2, it is 0 to E_{max} . Periodic electric field are impressed in between. E_{max} There is the switching field S where induction of the polarization P is rapidly carried out by impression electric field like drawing 2 to the front. While impression electric field are impressed from 0 to the switching field S, an electron is induced the near top face of the top-face electrode 3 of an antiferroelectric crystal 2.

[0031] If induction of the polarization is rapidly carried out in the switching field S at this time, the attracted above-mentioned electron will oppose this polarization, and an electron (it is henceforth called a cold electron) will come to be emitted from the front face of the antiferroelectric crystal 2 located in the part of the clearance between the top-face electrodes 3 of Kushigata according to the tunnel effect. Drawing 4 shows the situation in case this cold electron is generated rapidly, and a cold electron is rapidly emitted in the impression electric field near the switching field S. It is accelerated with the grid electrode 5, the emitted cold electron reaches the fluorescent substance layer 6, after passing the grid electrode 5, and the fluorescent substance layer 6 emits light by the predetermined color. This luminescence is recognized from the outside through glass 7.

[0032] Emission of a cold electron has stopped until emission of the above-mentioned cold electron stopped, impression electric field returned to 0 and it became near the switching field S again, when passing the switching field S. If impression electric field are repeated on a predetermined frequency, the above emission and emission halt of a cold electron will be repeated, and, thereby, the fluorescent substance layer 6 will repeat the process of luminescence and a luminescence halt. Since there is also residual luminescence of the fluorescent substance layer 6 when the frequency of the above-mentioned impression electric field is carried out more than a predetermined frequency, it is recognized as luminescence is continuing to human being's eyes. Therefore, use becomes possible as a drop by controlling impression and un-impressing by an external controller (not shown) etc. [of electric field]

[0033] As an antiferroelectric crystal 2, the ceramics of a Pb-La-Zr-Sn-Ti-O system, a Pb-Nb-Zr-Sn-Ti-O system, and a Pb-La-Zr-Ti-O system etc. can be used, for example. In this example, "Pb_{0.97} La_{0.02} Zr_{0.66} Sn_{0.24} Ti_{0.103}" called the PLZST ceramics is adopted, and thickness L2 of this ceramic layer is set to 30 micrometers. The polarization property of said drawing 2 shows the property of this adopted PLZST ceramics.

[0034] The wave of the impression electric field of the alternation power source 9 is fitted to the polarization property of this PLZST ceramics. For example, peak electric-field values are 45 kV/cm like drawing 3. The forward alternating electric field of a 100Hz triangular wave was impressed. Here, the peak electric-field value to impress is set up by said switching field S of an antiferroelectric crystal 2. In addition, the wave of an alternating electric field may not be limited to a triangular wave, and a rectangular pulse shape may be used, for example, an alternation frequency corresponds to the responsibility of an antiferroelectric crystal 2 etc., and it is several kHz. You may carry out.

[0035] the top-face electrode 3 and the rear-face electrode 4 -- for example, Pt, Au, Ag-Pd, Pd, aluminum, and Cu etc. -- it is constituted. It is more desirable to make the top-face electrode 3 into the structure of having a clearance so that an electron may be easy to be emitted from the front face of an antiferroelectric crystal 2 when an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4. Therefore, although the top-face electrode 3 of Kushigata like drawing 1 is adopted in this example, it is good also as an electrode with which this top-face electrode 3 prepared the clearance between the shape of a hole of predetermined magnitude inside the flat electrode for the above-mentioned reason.

[0036] And in a flat-surface drop which displays an alphabetic character and a graphic form, for example by dot display, a plane is made to line up in all directions, a display cel is put in order, and in matrix, each display cel is accessed and is driven in many cases. At this time, it is [antiferroelectric crystal / 2] more desirable to have made each intersect perpendicularly up and down, to have prepared, and to make this into the top-face electrode 3 and the rear-face electrode 4 in the electrode of Kushigata which specifies a matrix. Only the top-face electrode 3 is made into Kushigata in this example, and it is the electrode width of face L5 of this Kushigata. It may be 0.3mm.

[0037] moreover, the insulating substrate 8 -- for example, aluminum 2O₃, Mg O, and Si etc. -- you may be glass although constituted. When the fluorescent substance layer 6 emits light, the fluorescent substance layer 6 is formed in the inferior surface of tongue of glass 7 so that the luminescence can be seen from the exterior, but even if it constitutes glass 7 from the same insulator as the above insulating substrates 8, an operation of luminescence by the antiferroelectric crystal of this invention does not change.

[0038] Moreover, 1 side L1 like [in this example] drawing 1 The above-mentioned display device 1 is formed on the insulating substrate 8 of the shape of a square which is 10mm, and it is the distance L3 between the top-face electrode 3 and the grid electrode 5. Distance L4 between 10mm, the grid electrode 5, and the fluorescent substance

layer 6 It may be 5mm. Thus, since the distance between the top-face electrode 3 and the fluorescent substance layer 6 is long, the space between the top-face electrode 3 and glass 7 is held to the vacua, and the grid electrode 5 is provided in this space so that the emission electron may tend to reach the fluorescent substance layer 6. The degree of vacuum of the above-mentioned vacuum is 10Pa. It is good at extent made low, and has been hard coming to receive effect in a degree of vacuum conventionally. Since said cold electron is emitted from the whole front face of the antiferroelectric crystal 2 located in the part of the clearance between the top-face electrodes 3 of Kushigata, this is because the emission current becomes large and it was hard coming to receive effect in a degree of vacuum. [0039] Next, the second example is explained with reference to drawing 5. Drawing 5 expresses the cross section of the unit display cel of a display device 1. In this example, the following intermediate products 10 are used instead of the vacuum in the first example. For example, an insulator like silicon OKISAITO is used, making it into the thickness of hundreds of A or less, or a n-type semiconductor or inert gas is used. Other configurations are the same as that of the first example.

[0040] If an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4 like the above-mentioned also in this case, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2. At the time of an insulator when the above-mentioned intermediate product 10 is very thin, this cold electron is accelerated with the grid electrode 5, and an insulator with a thickness of hundreds of A or less is passed, and it reaches the fluorescent substance layer 6. Moreover, if the above-mentioned cold electron is poured in at the time of a n-type semiconductor, it will be accelerated with the grid electrode 5 with an internal suspension electron, and this cold electron will reach the fluorescent substance layer 6. At the time of inert gas, the above-mentioned cold electron is similarly accelerated in the inside of inert gas, and the fluorescent substance layer 6 is reached.

[0041] Thus, since a vacuum is not used, there are no problems, like the structure for maintaining reinforcement so that the glass 7 used for the screen of a drop may not be crushed by the vacuum becomes complicated. Therefore, it becomes easy to enlarge a drop. Moreover, a very thin drop can be constituted compared with the case where a vacuum is used.

[0042] The third example is explained based on drawing 6. Drawing 6 expresses the cross section of the unit display cel of a display device 1. On an insulating substrate 8, the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 of Kushigata are formed in order like an above-mentioned example. A predetermined distance is kept above the top-face electrode 3, glass 7 is arranged, and the grid electrode 5 is formed in the inferior surface of tongue of glass 7. Furthermore, an antiferroelectric crystal 2 is countered and the fluorescent substance layer 6 is formed in the inferior surface of tongue of the grid electrode 5. Moreover, in this example, the same intermediate product 10 as the 2nd example is used between the top-face electrode 3 and glass 7. The connection of the alternation power source 9 with each electrode is the same as that of an old example.

[0043] An operation of this example becomes being the same as that of the second example of the above. And since a vacuum is not used also in this case, it becomes easy to enlarge a drop. Furthermore, since the grid electrode 5 was formed between glass 7 and the fluorescent substance layer 6, distance of the fluorescent substance layer 6 and the top-face electrode 3 can be made smaller than the second example, and a therefore further thin drop can be constituted.

[0044] The fourth example is explained based on the sectional view of the unit display cel of the display device 1 shown in drawing 7. In this example, the rear-face electrode 4 and the antiferroelectric crystal 2 are formed in the upper part of an insulating substrate 8 in order. The top-face electrode 3 and the fluorescent substance layer 6 of Kushigata are formed in the top face of an antiferroelectric crystal 2 by turns. Namely, it is in the condition that the fluorescent substance layer 6 was arranged between the electrodes of Kushigata. And glass 7 is arranged in the top face of the top-face electrode 3 and the fluorescent substance layer 6.

[0045] If an alternating electric field is impressed between the top-face electrode 3 and the rear-face electrode 4 like the above-mentioned, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2. This cold electron is irradiated by the fluorescent substance layer 6 which is in a top face immediately, and luminescence of a fluorescent substance is checked with glass 7 from the exterior. Thus, in this example, since an antiferroelectric crystal 2 and the fluorescent substance layer 6 are contacted and are arranged, when there is no intermediate product 10 like a last example and a drop is constituted, it can be made a thin shape very much. Moreover, since a vacuum is not used, it becomes easy to enlarge a drop.

[0046] The fifth example is explained with reference to drawing 8. The example which this example arranges a unit display cel to a plane in all directions, and constitutes a flat-surface drop is shown, and drawing 8 expresses the sectional view of the display device 1. Although the rear-face electrode 4, the antiferroelectric crystal 2, and the top-face electrode 3 are formed in the upper part of an insulating substrate 8 in order, the rear-face electrode 4 and the top-face electrode 3 are used as the electrode of Kushigata which lies at right angles to each other. For example, each Kushigata electrode of the rear-face electrode 4 is arranged like drawing 8 to the x axis of the x-y flat surface of a flat-surface drop, and parallel, and each Kushigata electrode of the top-face electrode 3 is arranged to the y-axis and parallel. The tandem-type electrode of the tandem-type electrode of at least one rear-face electrode 4 and at

least one top-face electrode 3 is arranged by each unit display cel C. In this example, one rear-face electrode 4 and two top-face electrodes 3 are arranged in each unit display cel C, and the fluorescent substance layer 6 is formed between two top-face electrodes 3. Inside the top-face electrode 3, the hole of predetermined magnitude may be prepared like drawing 9, and the fluorescent substance layer 6 may be formed into this hole. the top-face electrode 3 and the fluorescent substance layer 6 -- glass 7 is immediately formed in the top face. Moreover, an intermediate product 11 is formed between the top-face electrodes 3 of each unit display cel C which adjoined. This intermediate product 11 may consist of an insulator (a gas, a liquid, and a solid-state are not asked) or air, a vacuum, etc.

[0047] If an alternating electric field is impressed between the top-face electrode 3 of each unit display cel C, and the rear-face electrode 4, a cold electron will be emitted from the up front face of an antiferroelectric crystal 2, the fluorescent substance layer 6 which has this cold electron in a top face immediately will irradiate, and a fluorescent substance will emit light. At this time, the above-mentioned alternating electric field is controlled in matrix between the top-face electrode 3 and the rear-face electrode 4, and an alternating electric field is impressed so that the unit display cel C of a position may emit light. namely, the rear-face electrode 4 for every unit display cel C -- the y-axis electric-field controller 15 -- respectively -- the power-source line y1, y2, and y3 etc. -- it connects -- having -- moreover, the top-face electrode 3 for every unit display cel C -- the x-axis electric-field controller 16 -- respectively -- the power-source line x1, x2, and x3 etc. -- it connects. And the alternation power source 9 is connected to this x-axis electric-field controller 16 and the y-axis electric-field controller 15.

[0048] Drawing 10 expresses the example of electric-field control of the x-axis electric-field controller 16 and the y-axis electric-field controller 15. the y-axis electric-field controller 15 -- a predetermined period -- cyclic -- each power-source line y1, y2, and y3 etc. -- only predetermined time is connected to the alternation power source 9. power-source line y1 the time of connecting with the alternation power source 9 -- the x-axis electric-field controller 16 -- power-source line x1 The power-source line x1 of the top-face electrode 3 corresponding to the cel which should be turned on in each unit display cels C11 and C21 and C31 grade which are located on the corresponding rear-face electrode 4, x2, and x3 etc. -- it connects with the alternation power source 9. An alternating electric field is impressed only to the cel which should be turned on by this, and this cel turns on only the above-mentioned predetermined time by it. the power-source line x1 corresponding to the cel which should be turned on to the alternation power source 9 corresponding to each power-source line by which sequential connection was made, x2, and x3 etc. -- it can connect with the alternation power source 9, and can go, and the unit display cel C of a position can be made to emit light in matrix [thus,]

[0049] In both this examples, since it is arranging so that the rear-face electrode 4 and the top-face electrode 3 may be used as the electrode of Kushigata and it may intersect perpendicularly with each other, each unit display cel is chosen in matrix, and it can display on arbitration. Therefore, it becomes possible to constitute as a flat-surface drop which can display an alphabetic character, a graphic form, etc. Since an antiferroelectric crystal 2 and the fluorescent substance layer 6 are contacted and are arranged like a last example, a drop becomes a thin shape very much. Moreover, when not using a vacuum, it becomes easy to enlarge a drop. If a hole is prepared inside the top-face electrode 3 and the fluorescent substance layer 6 is formed into this hole, interference of luminescence of each unit display cels will decrease.

[0050] Next, the sixth example is explained based on drawing 11. Drawing 11 expresses the sectional view of the display device 1 when constituting a flat-surface drop like the 5th example. The rear-face electrode 4, an antiferroelectric crystal 2, and the top-face electrode 3 are formed in the upper part of an insulating substrate 8 in order, and the rear-face electrode 4 and the top-face electrode 3 are used as the electrode of Kushigata which lies at right angles to each other like the above-mentioned. Moreover, the fluorescent substance layer 6 is formed in the top face of the top-face electrode 3, and glass 7 is arranged in the top face of the fluorescent substance layer 6. You may constitute from the insulator or air of an intermediate product 11, a vacuum, etc. like a last example between an antiferroelectric crystal 2 and glass 7.

[0051] If an alternating electric field is impressed between the top-face electrode 3 of each unit display cel C, and the rear-face electrode 4, a cold electron is emitted from the up front face of an antiferroelectric crystal 2, this cold electron will pass an intermediate product 11, will be irradiated by the fluorescent substance layer 6, and a fluorescent substance will emit light. At this time, the above-mentioned alternating electric field is controlled in matrix between the top-face electrode 3 and the rear-face electrode 4 like a last example, and an alternating electric field is impressed so that the unit display cel C of a position may emit light. Therefore, the display cel of arbitration is chosen in matrix, and can be displayed, and it becomes possible to constitute as flat-surface drops, such as an alphabetic character and a graphic form.

[0052] In addition, in the example of the luminescence display device explained until now, although the operation which an alternating electric field is impressed to an antiferroelectric crystal, and makes a cold electron emit was explained with reference to the numeric value, an operation and effectiveness of this invention are not limited only to these numeric values, and the above-mentioned numeric value is set up with the specification of the drop to make, the engine performance, etc., corresponding to the property of the antiferroelectric crystal to be used.

therefore, a setup of those other than the above-mentioned numeric value -- or it cannot be overemphasized that the antiferroelectric crystal of other properties is used and what has the same operation and effectiveness can be constituted within the limits of the main point of this invention.

[0053]

[Effect of the Invention] Since the antiferroelectric crystal was used, the emission current can be enlarged. Moreover, the emission current of the magnitude stabilized even if it did not use a vacuum is acquired. Moreover, since the internal stress of the antiferroelectric crystal generated according to the piezo-electric effect by impression of an alternating electric field is small, the life of a display device can be improved. Furthermore, since polarization becomes zero when the above-mentioned impression electric field are made into zero, even when a flat-surface drop is constituted, there is no irregular luminescence of a fluorescent substance, and it can improve the responsibility of luminescence of a fluorescent substance. Consequently, it is durable and work of the bright luminescence display device excellent in the display property is attained.

[0054] Since it became unnecessary to have formed the emission section of a cold electron with the precise formation process, the formation process of a display device was simplified. Therefore, a component with a uniform property is obtained easily and it becomes easy to make the drop of a large area. Moreover, since the electron was emitted from the flat-surface section, it also becomes possible to pass a high current and the display stabilized even if it passed the long duration current further came to be obtained. Therefore, the display engine performance and dependability have been improved.

[0055] When a flat-surface drop is constituted, each unit display cel can be arranged in matrix to a plane, at least, either of the two electrodes can be made into Kushigata, the top-face electrode 3 and the rear-face electrode 4 of an antiferroelectric crystal which lie at right angles to each other up and down can be prepared, these two electrodes can be chosen in matrix, and an alternating electric field can be impressed. Therefore, it became easy to make the unit display cel of the arbitration of a flat-surface drop emit light. If a hole is prepared inside the top-face electrode 3 and a fluorescent substance layer is formed in this hole at this time, interference of luminescence of each unit display cels can be lessened. Consequently, it became possible to constitute a flat-surface drop easily.

[0056] The cold electron emitted from an antiferroelectric crystal reaches a fluorescent substance layer, makes a fluorescent substance emit light, and can check this luminescence from the cel outside through the glass of the upper part of a fluorescent substance layer. Therefore, the luminescence display device has consisted of easy structures.

[0057] Since the cold electron emitted from the antiferroelectric crystal reaches a fluorescent substance layer very efficiently when vacuum gas is used, whenever [luminescence / of a fluorescent substance] can be enlarged. Structure can be simplified when an insulator or a n-type semiconductor is used instead of vacuum gas. Since the semi-conductor constituted the whole display device at this time, the configuration became easy and correspondence of it was attained easily at the thin shape, the light weight, and the miniaturization.

[0058] Since the emission current can be enlarged, luminescence can be made bright. Moreover, since it was stable even if the display property used it for a long period of time, dependability has been improved.

[0059] The flat-surface drop of a large area with which a display property with simply uniform structure is acquired stably can constitute now easily.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

- [Drawing 1] It is the sectional view of the display device concerning the first example of this invention.
- [Drawing 2] It is the electric-field-polarization property Fig. of the antiferroelectric crystal explaining an operation of the first example.
- [Drawing 3] It is the wave form chart of the alternating electric field explaining an operation of the first example.
- [Drawing 4] It is the emission charge property Fig. of the antiferroelectric crystal explaining an operation of the first example.
- [Drawing 5] It is a display device sectional view concerning the second example of this invention.
- [Drawing 6] It is a display device sectional view concerning the third example of this invention.
- [Drawing 7] It is a display device sectional view concerning the fourth example of this invention.
- [Drawing 8] It is a display device sectional view concerning the fifth example of this invention.
- [Drawing 9] the hole concerning the fifth example of this invention -- it is the example of an aperture top-face electrode.
- [Drawing 10] It is the example of the electric-field control explaining an operation of the fifth example of this invention.
- [Drawing 11] It is a display device sectional view concerning the sixth example of this invention.
- [Drawing 12] It is the sectional view of the display device of ferroelectric use of the conventional technique.
- [Drawing 13] It is the sectional view of the display device of p-n junction use of the conventional technique.
- [Drawing 14] It is the explanatory view of the internal stress of the display device of ferroelectric use of the conventional technique.
- [Drawing 15] It is the electric-field-polarization property Fig. of the ferroelectric of the conventional technique.

[Description of Notations]

- 1 Luminescence Display Device
- 2 Antiferroelectric Crystal
- 3 Top-Face Electrode
- 4 Rear-Face Electrode
- 5 Grid Electrode
- 6 Fluorescent Substance Layer
- 7 Glass
- 8 Insulating Substrate
- 9 Alternation Electrode
- 10 Intermediate Product
- 11 Intermediate Product
- 15 Y-axis Electric-Field Controller
- 16 X-Axis Electric-Field Controller
- 81 Cel
- 82 Insulating Substrate
- 83 Lower Electrode Layer
- 84 Ferroelectric Layer
- 85 Up Electrode Layer
- 86 Glass Cell
- 87 Fluorescent Substance Layer
- 88 Power Source
- 89 Bias Electrode
- 90 Bias Power Supply
- 91 P Type Semiconductor Substrate

92 P Mold Impurity Range
93 N Mold Impurity Range
94 Oxide Film
95 Chip Section
96 Insulator Layer
97 Conductive Layer
98 Junction Field
Emax The impression maximum electric-field value
P Polarization
S Switching field

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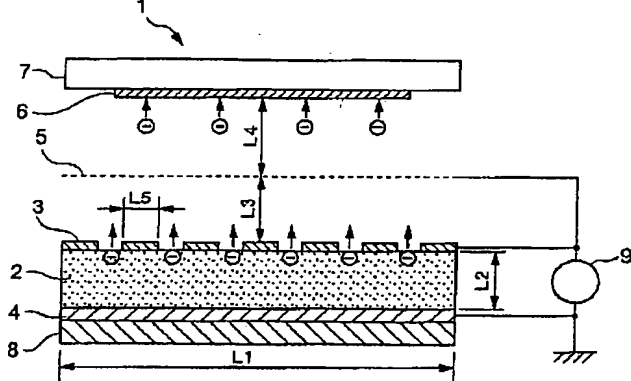
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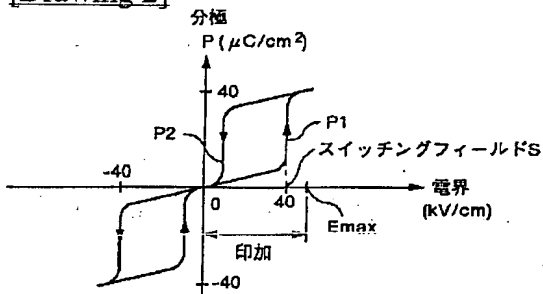
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DRAWINGS

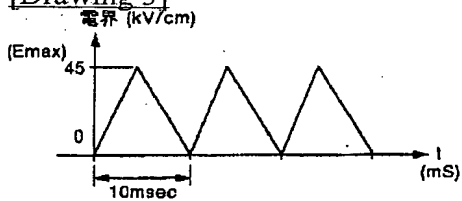
[Drawing 1]



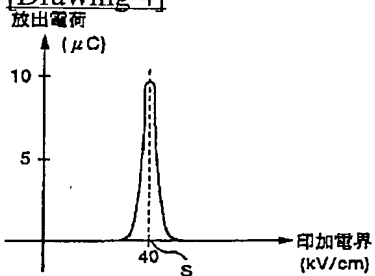
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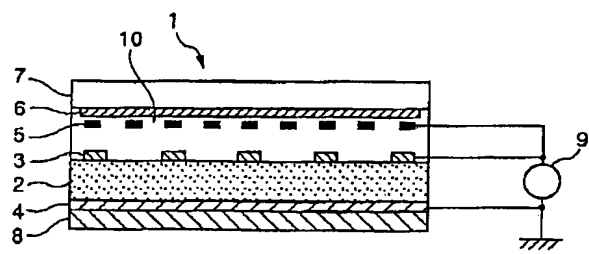
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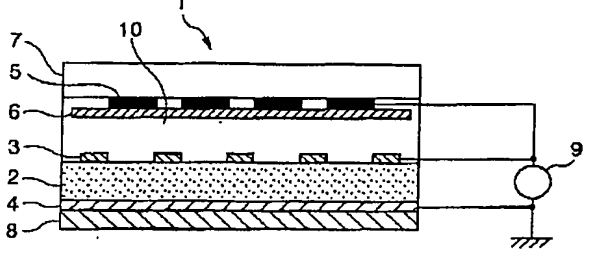
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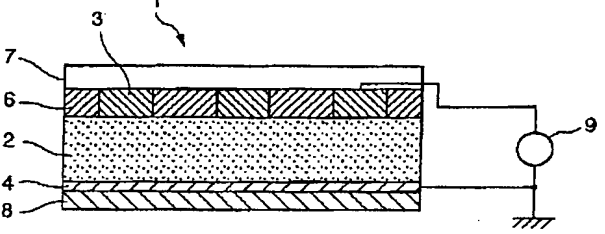
[Drawing 5]



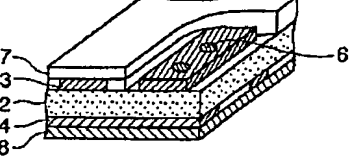
[Drawing 6]



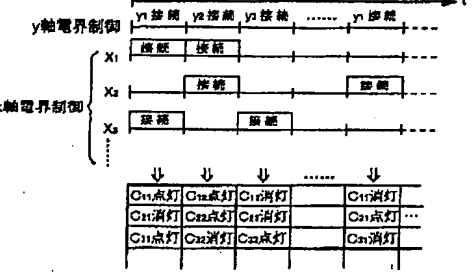
[Drawing 7]



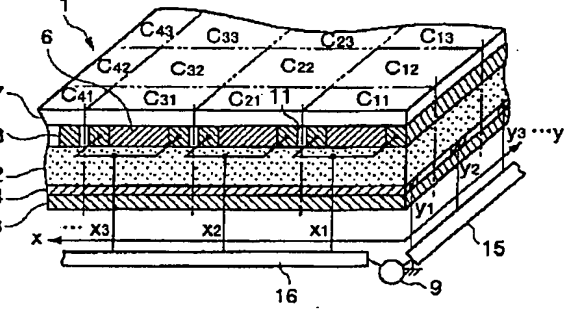
[Drawing 9]



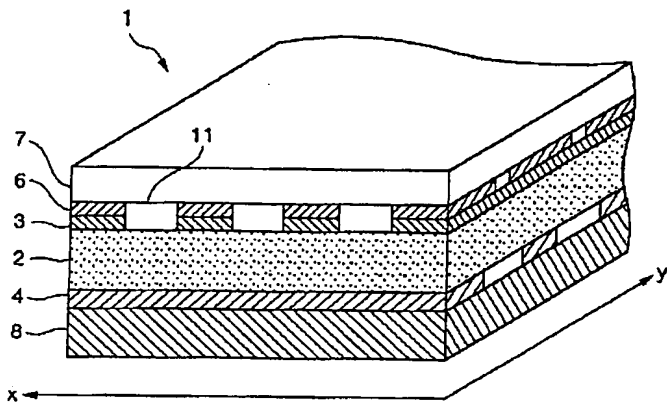
[Drawing 10]



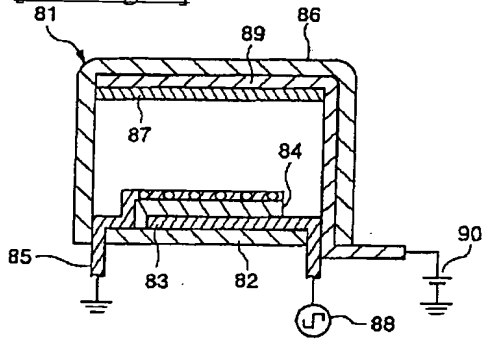
[Drawing 8]



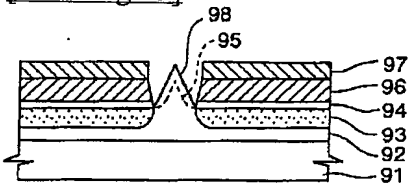
[Drawing 11]



[Drawing 12]



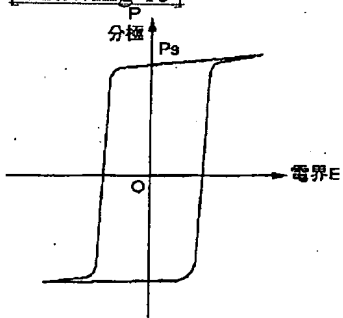
[Drawing 13]



[Drawing 14]



[Drawing 15]



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